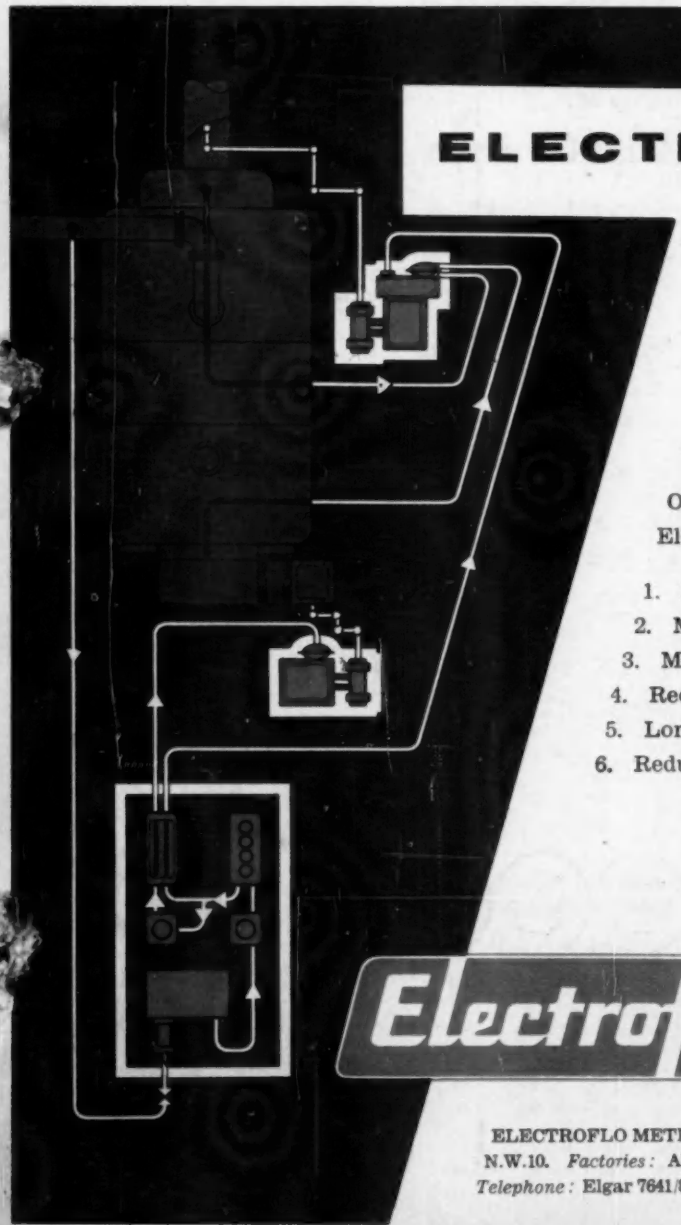
ENGINEERING AND
BOILER HOUSE REVIEW

VOL. 73 NO. 4 • THE PIONEER STEAM JOURNAL • APRIL, 1958



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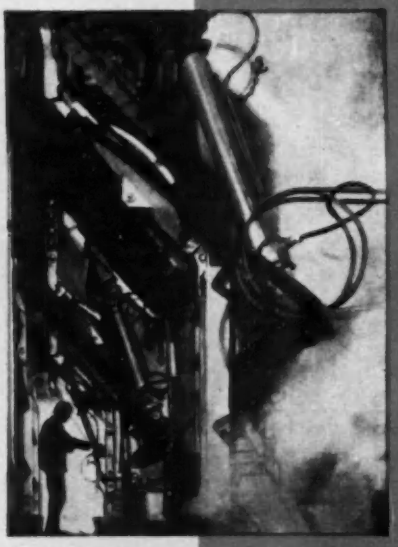

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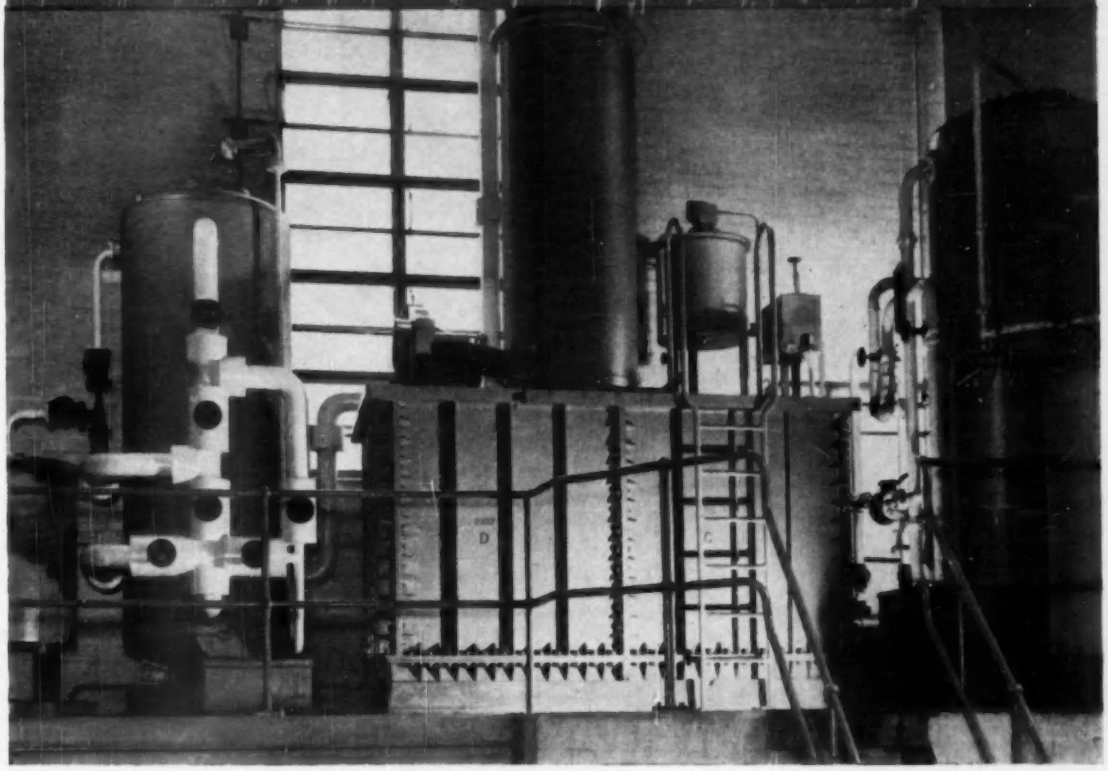

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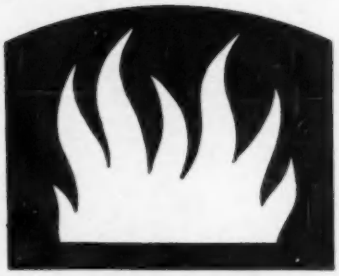

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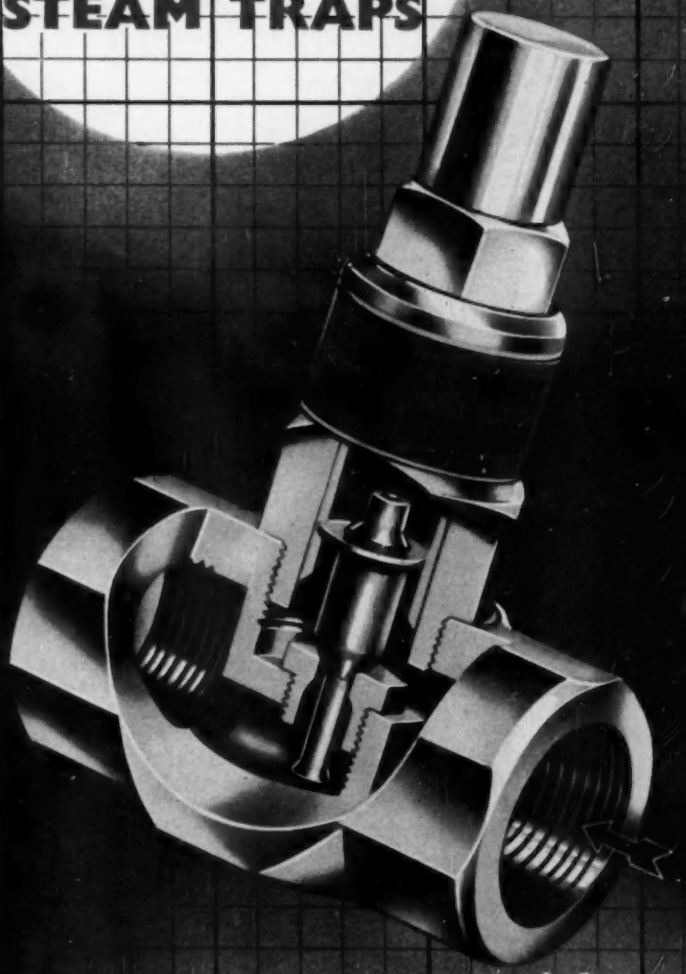

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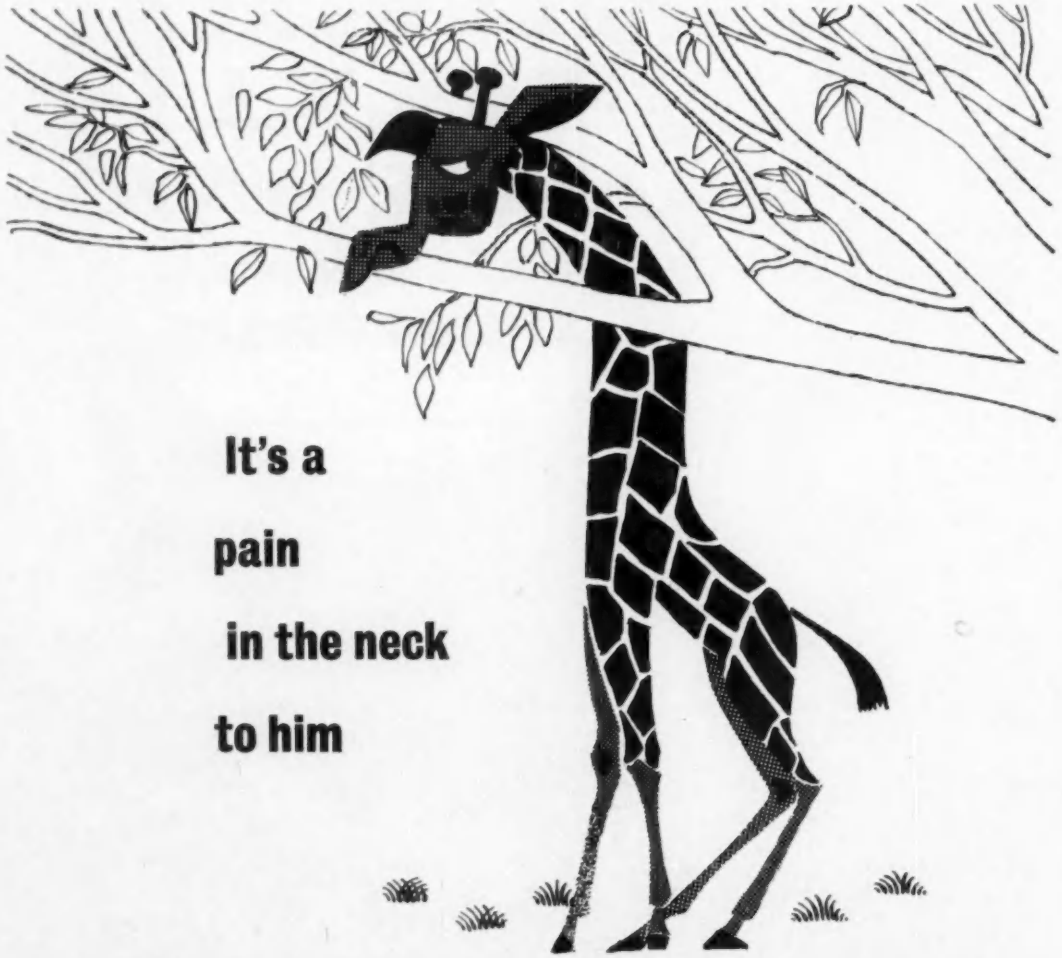

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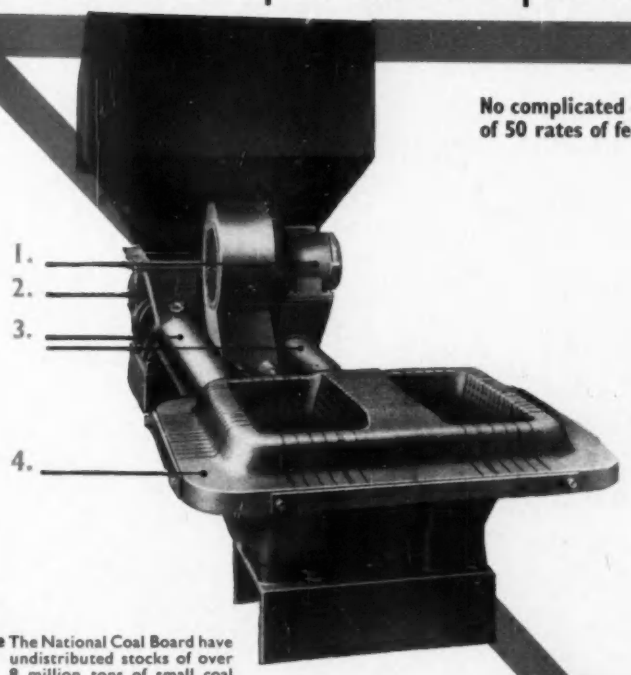

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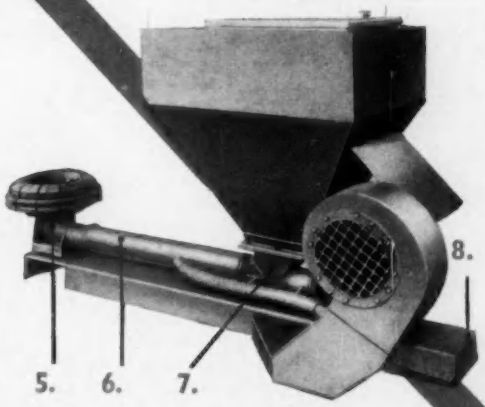

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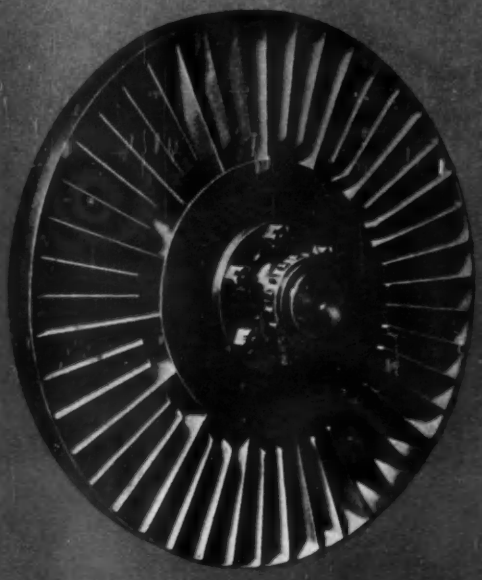

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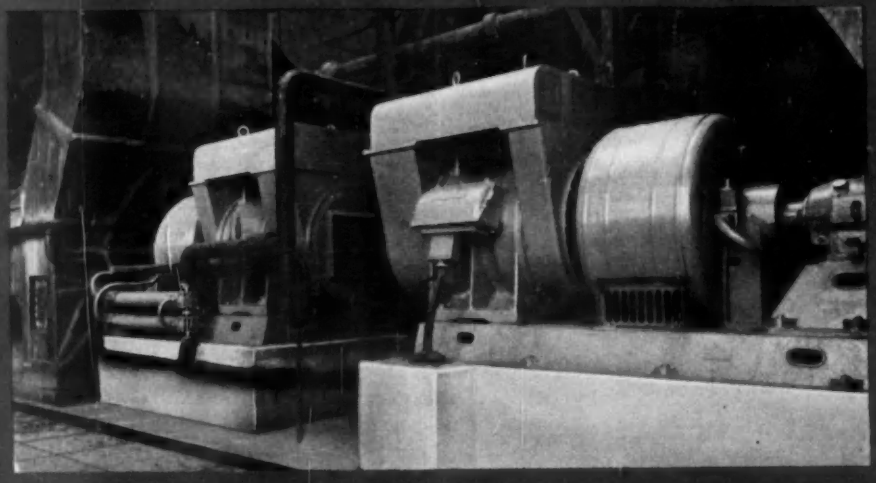

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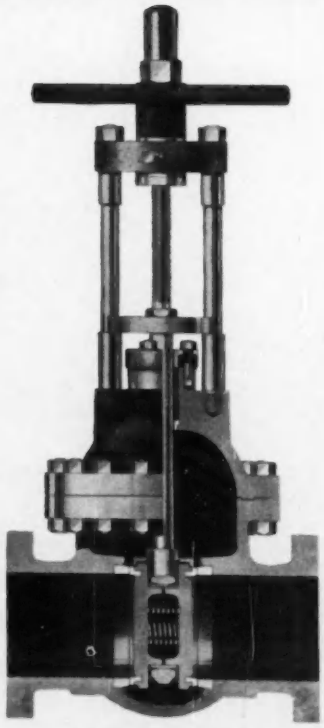

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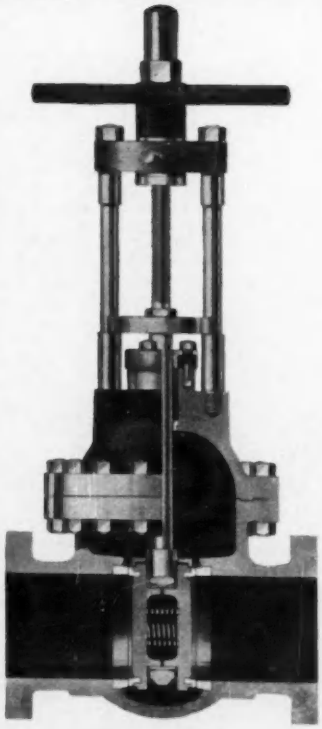

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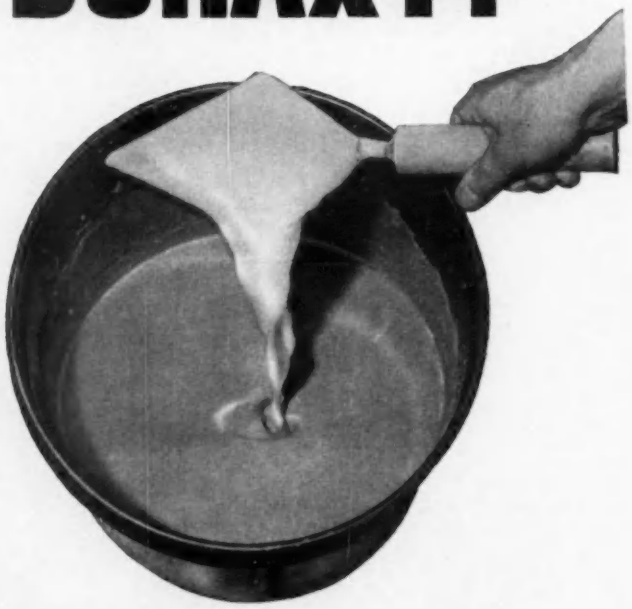

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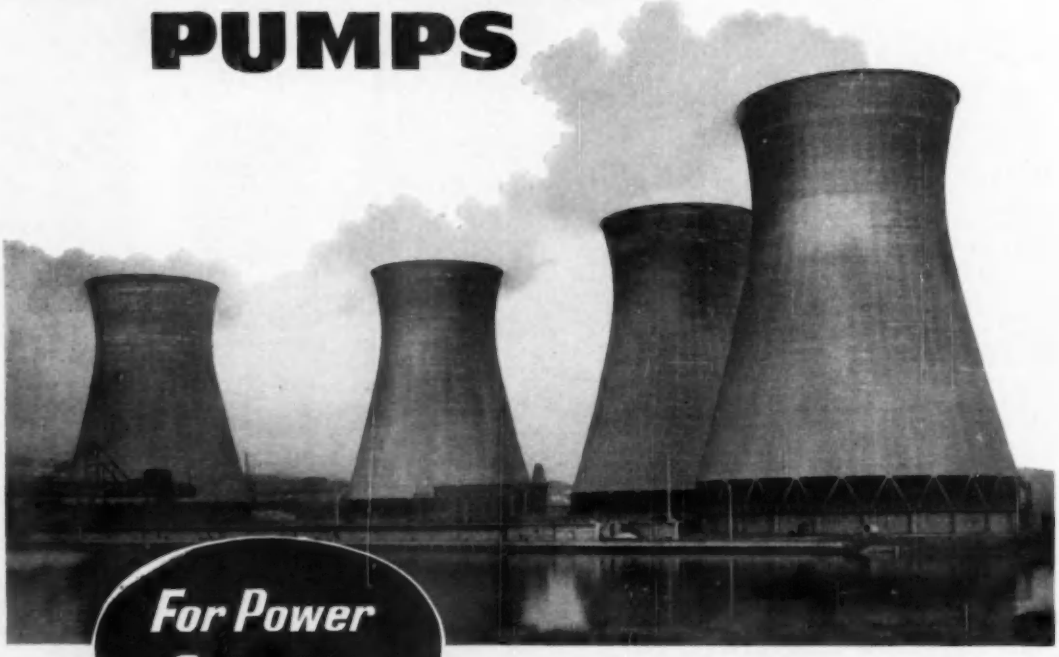

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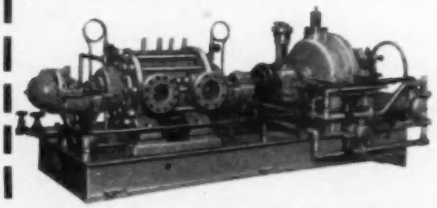
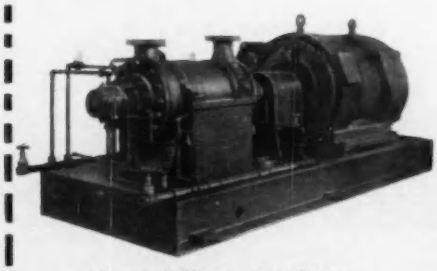
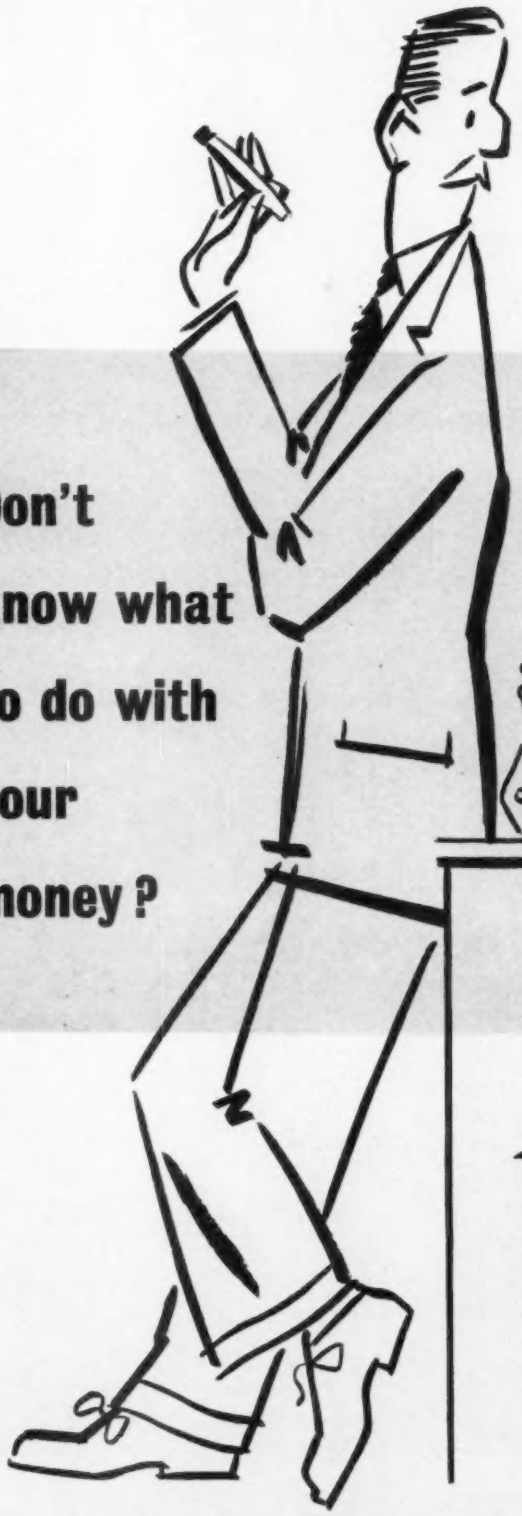




Sigmund Electro Feed Pump



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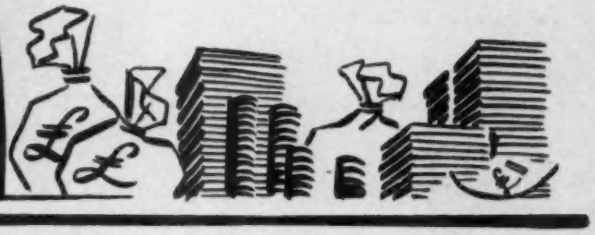

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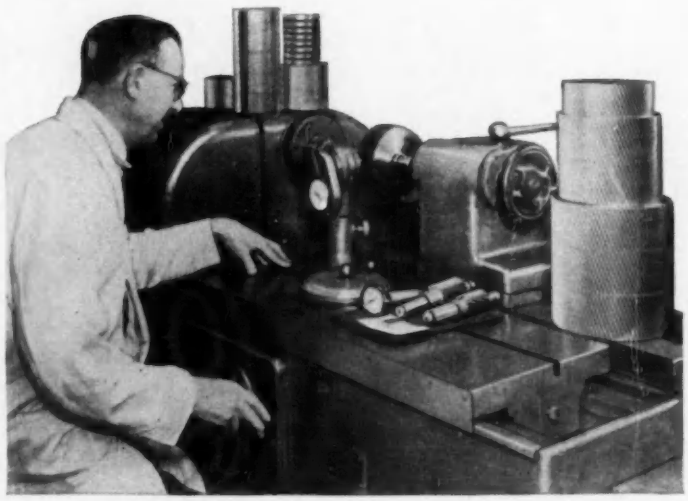

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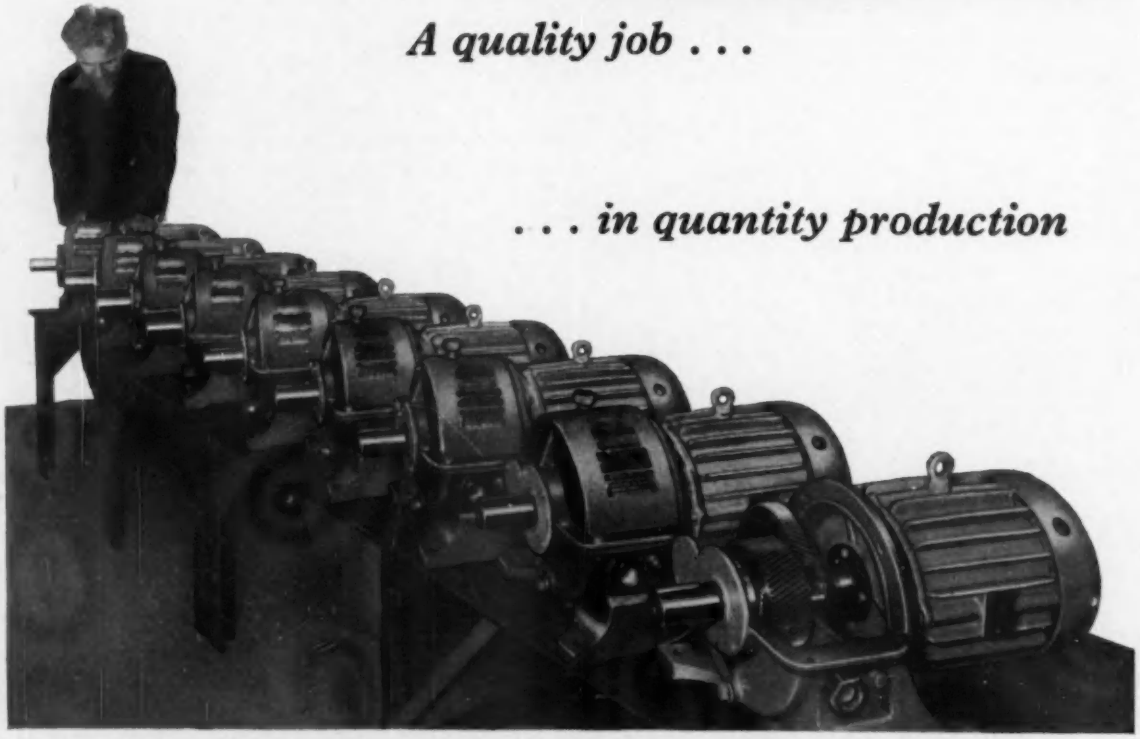

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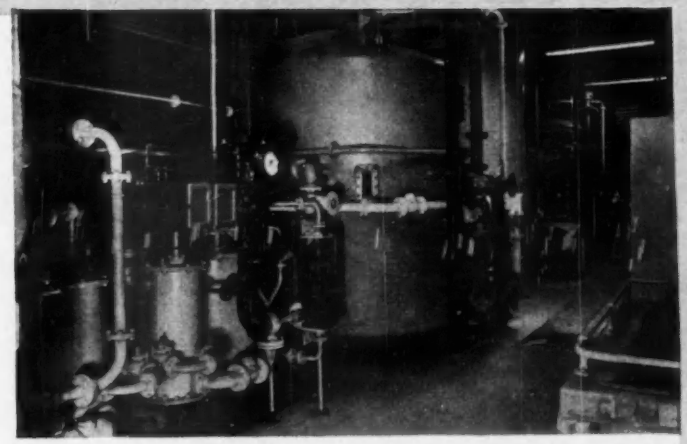
AS198

B3

WATER TREATMENT BY DE-IONISATION



John Thompson-Kennicott de-ionisation plant at the North Wilford Power Station of the Central Electricity Authority producing 75,000 gallons of treated water in 14 hours for high pressure water tube boilers from Nottingham Corporation Town supply, consisting of:

Cation Exchanger.
Scrubber.
Weekly basic Anion Exchanger.
Final Mixed Bed De-ionisation unit.

Water produced by the Kennicott De-ionisation process is of better quality than the distilled water normally obtained from evaporation. De-ionisation plant in the majority of cases involves less capital outlay and lower operational costs than any other method of producing water of this purity.

Plants can be made ranging in capacity from 100 gallons per hour to many thousands of gallons per hour.

Analysis of water as below.

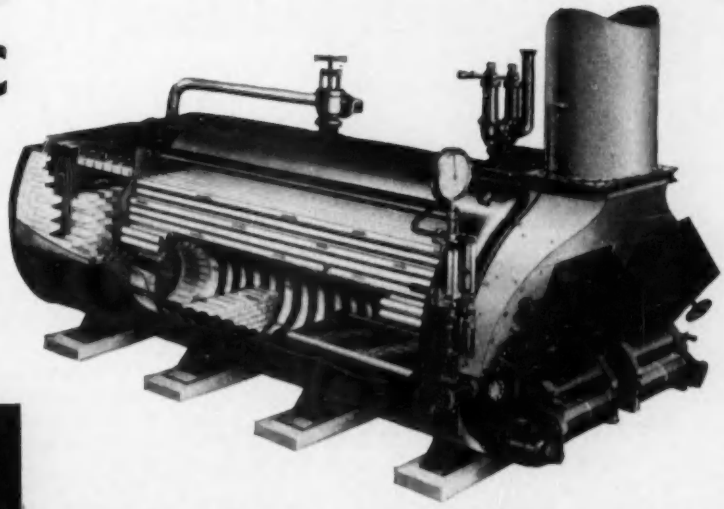
	AS SUPPLIED	AFTER TREATMENT
TOTAL HARDNESS	322 p.p.m.	NIL
ALKALINE HARDNESS	150 p.p.m	NIL
TOTAL DISSOLVED SOLIDS	Ranging from 587-638 p.p.m.	IMMEASURABLE
ELECTRICAL CONDUCTIVITY	660	0.1—0.2

The feed water thus produced has a silica content of less than 0.1 p.p.m. and is as free from ionisable solids as can exist.

JOHN THOMPSON-KENNICOTT LTD WOLVERHAMPTON

KD/2

ECONOMIC BOILERS



The Wilson Double Pass Economic Boiler has additional heating surface provided by a return pass of smoke tubes to the front of the boiler. This arrangement not only gives a high efficiency, but makes a very compact unit, self contained and requiring no brickwork setting. As illustrated the boiler has a Thompson-Triumph travelling grate stoker and superheater, but other equipment can be furnished as required.

Left: Fusion welded boiler shells are examined by modern radiographic methods.

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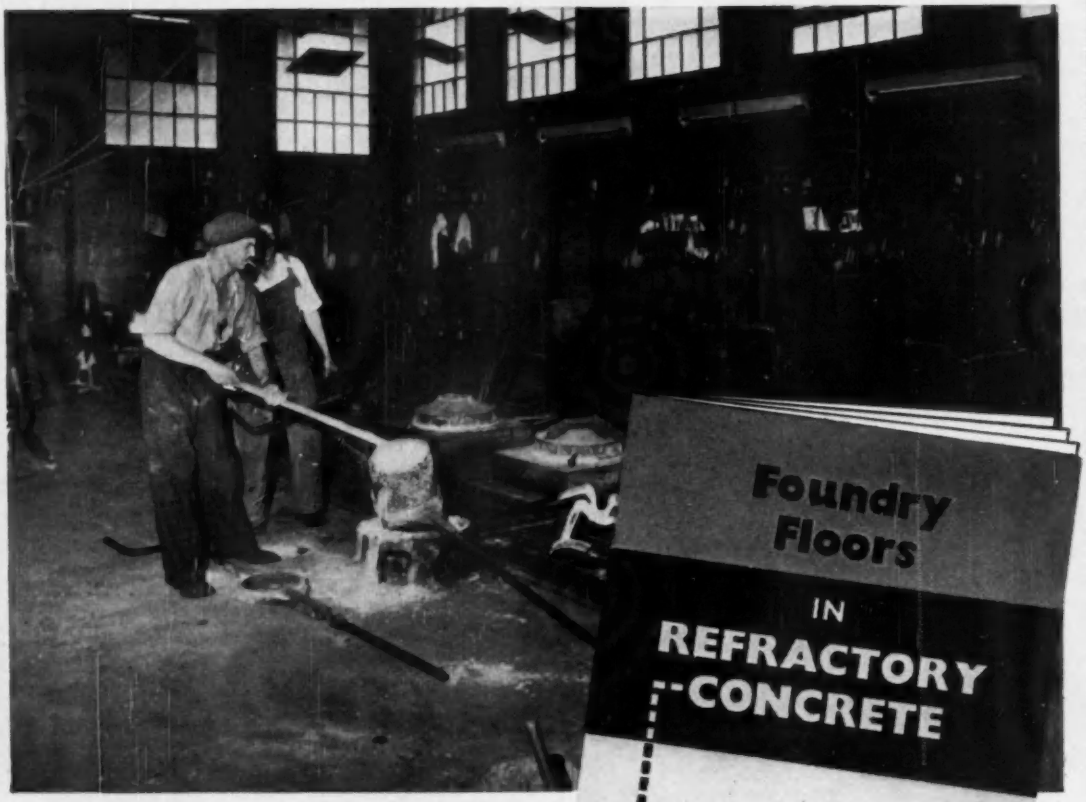
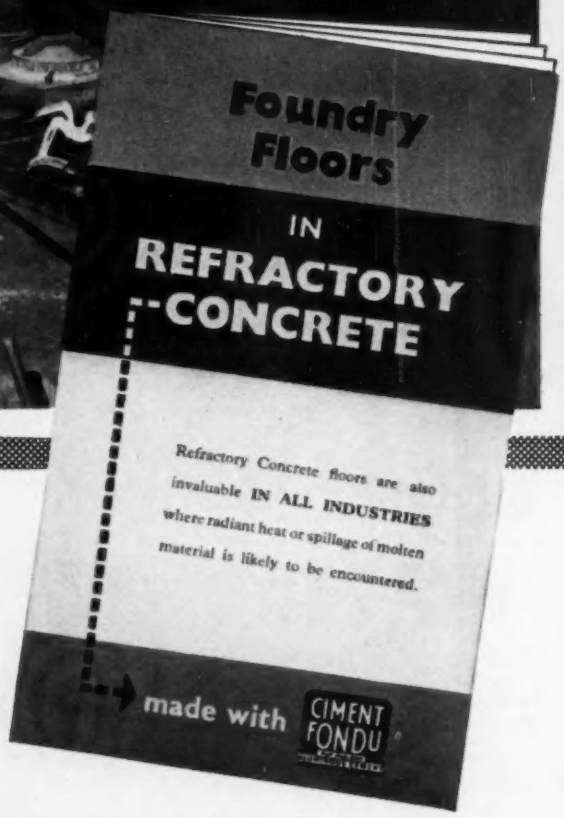
GI/4

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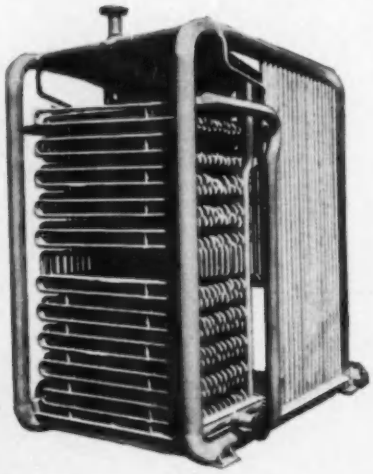

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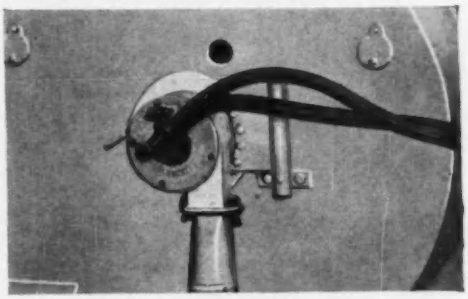

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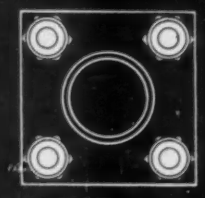

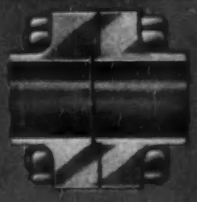

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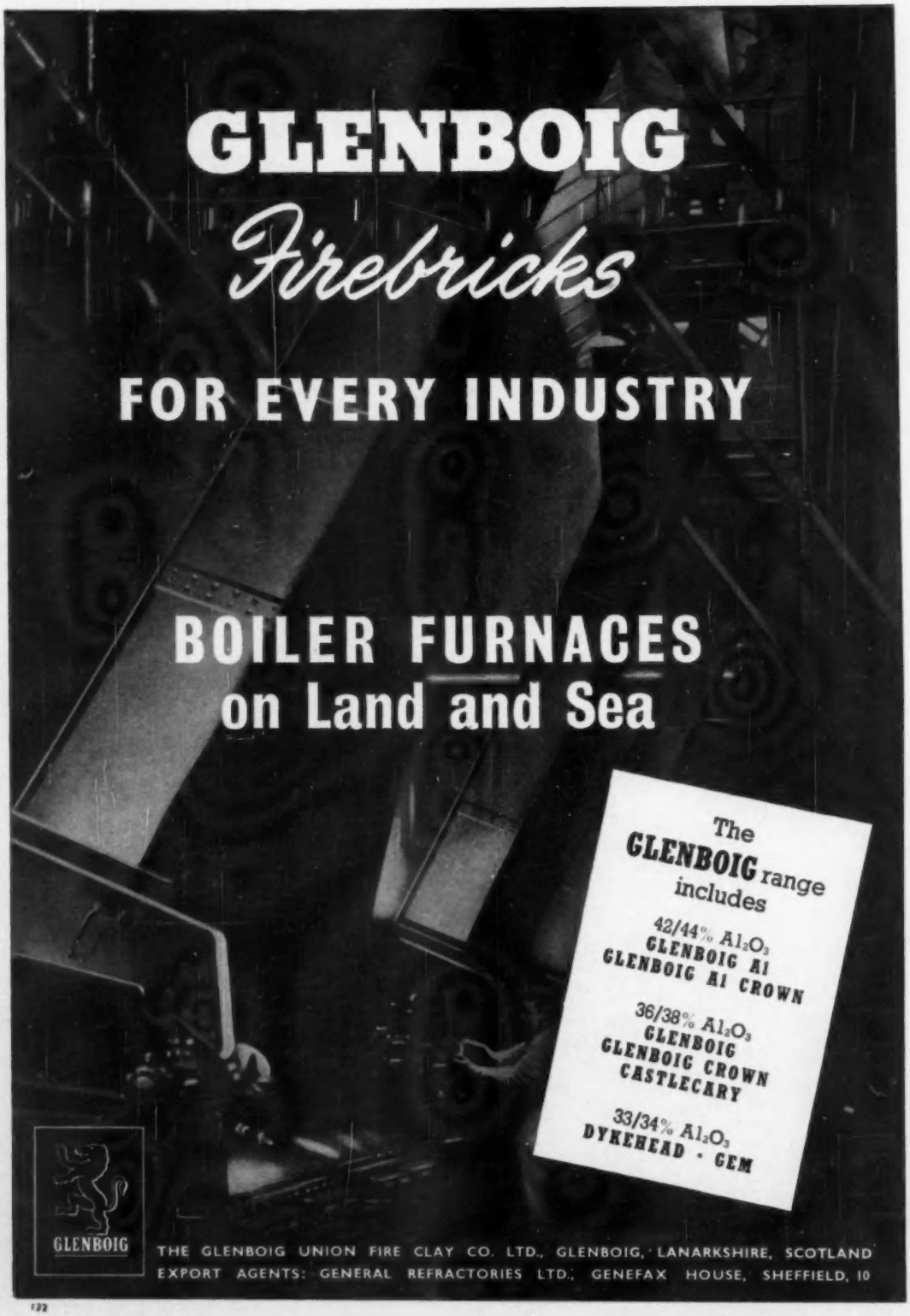
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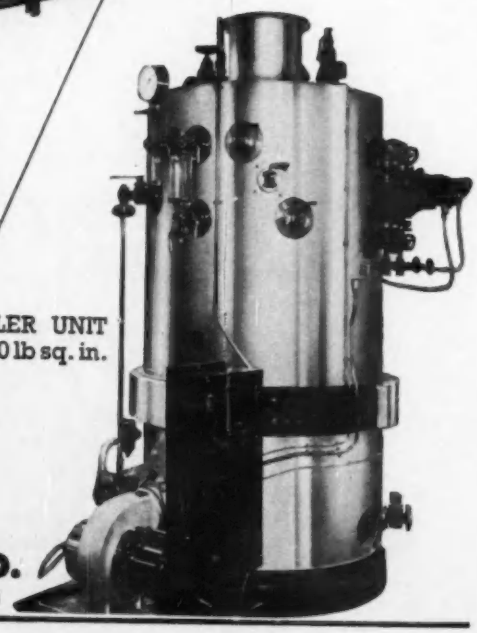

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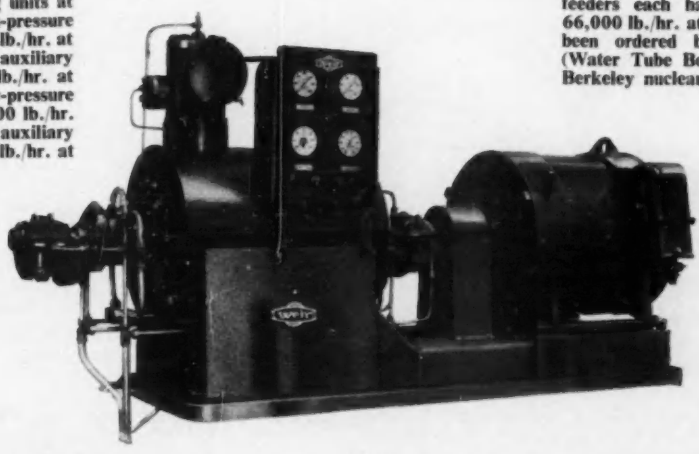

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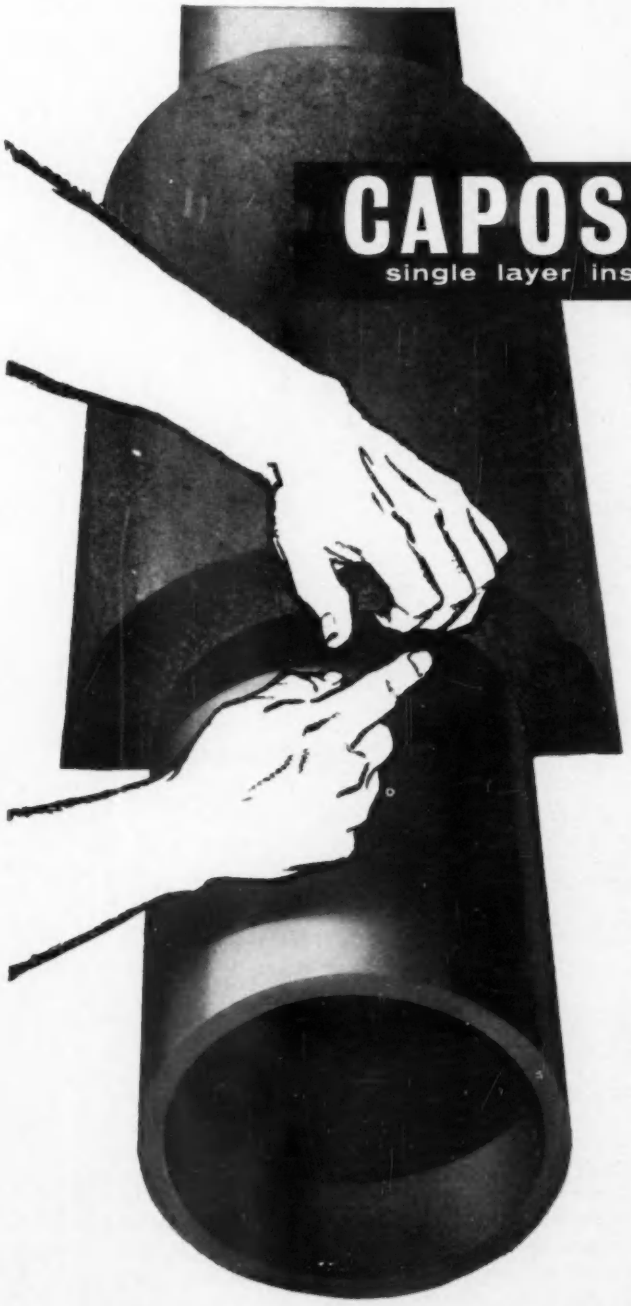

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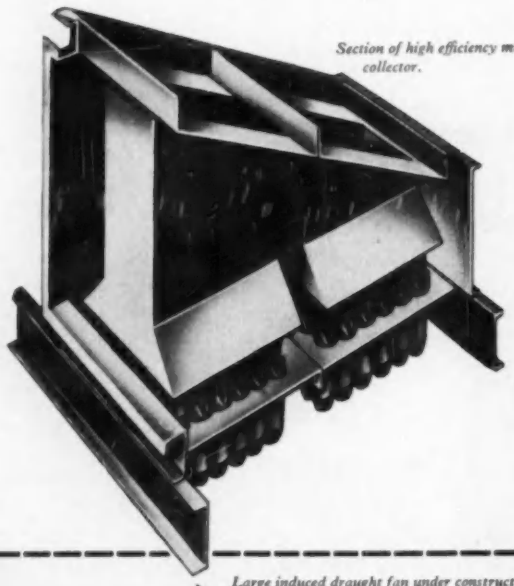

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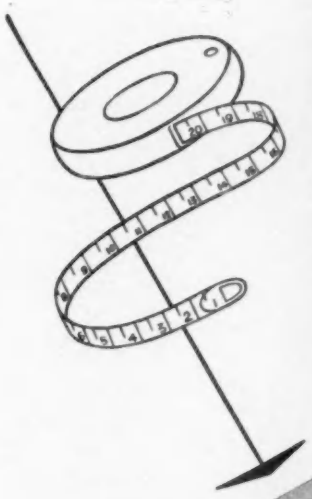

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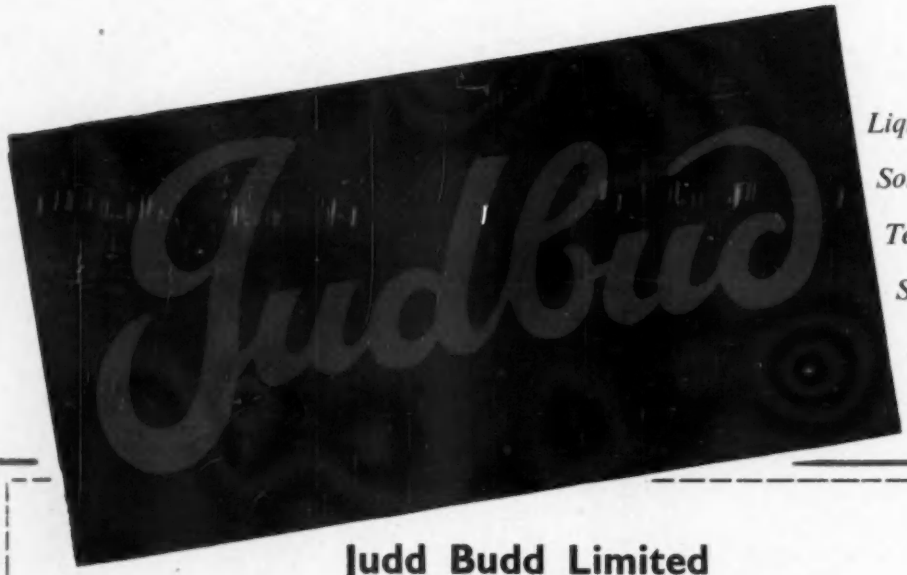

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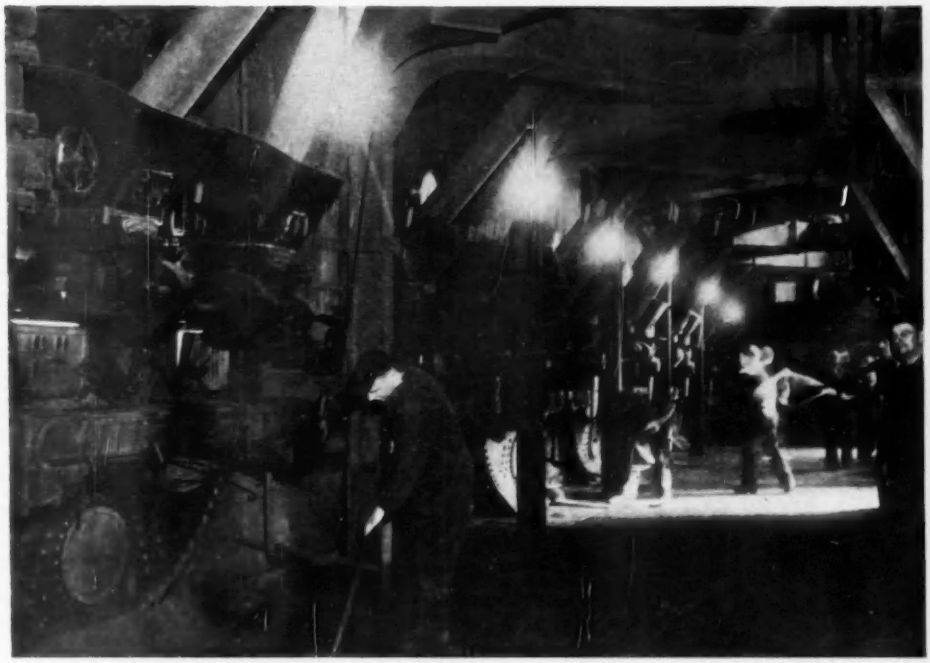

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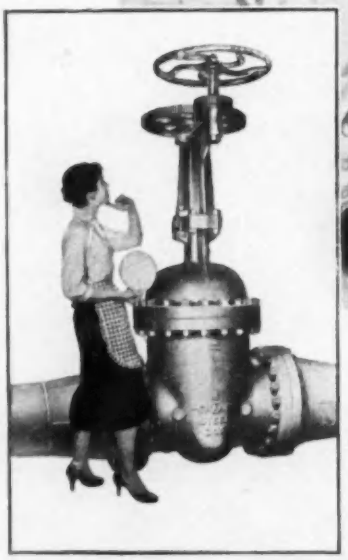

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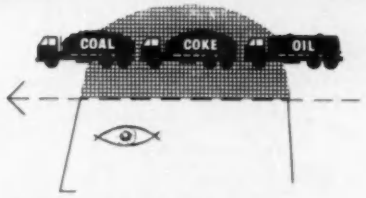

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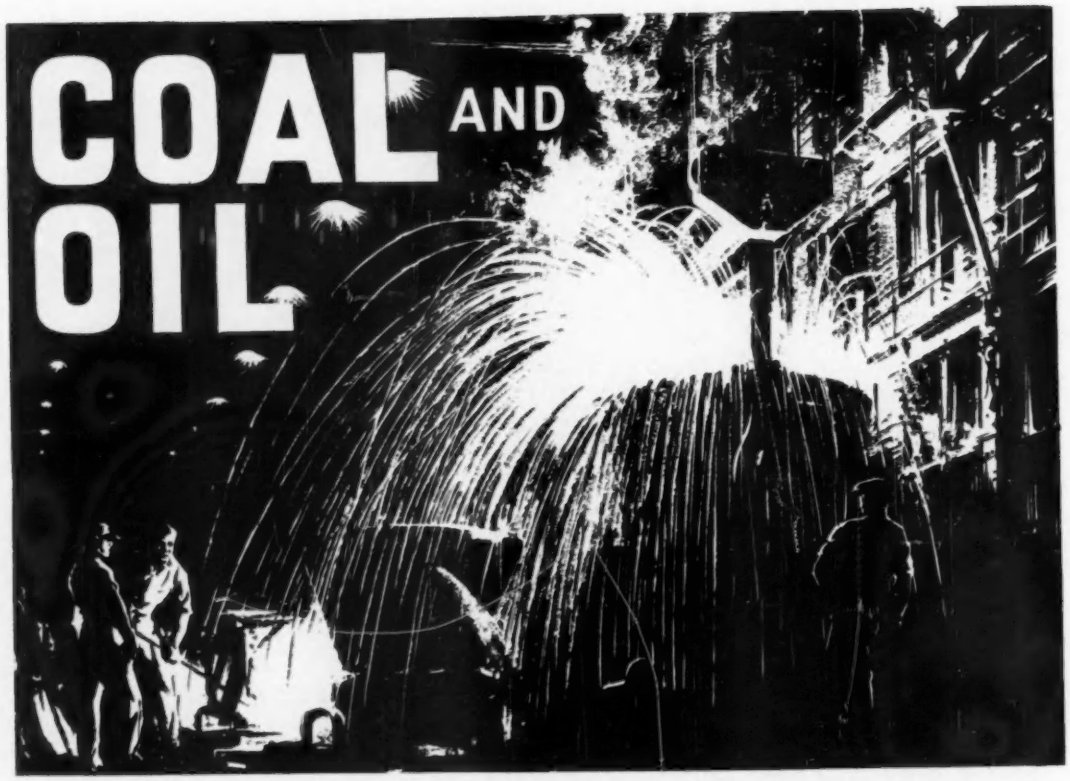

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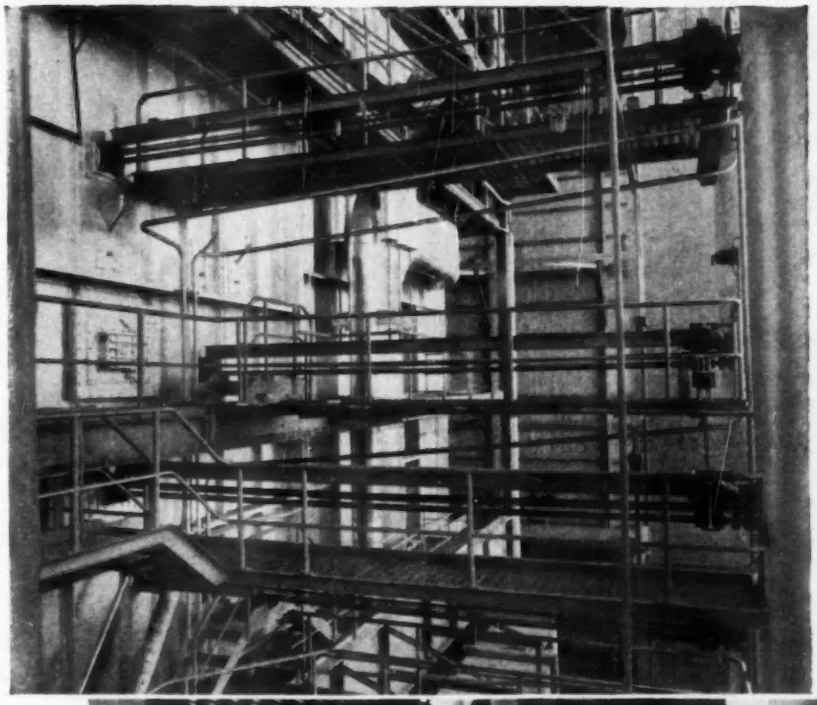
HOPKINSONS' SOOT BLOWERS
at a Continental Power Station



Long Retracting Blowers, sequence-controlled

The photographs show our soot blowing equipment installed at a notable power station in Holland.

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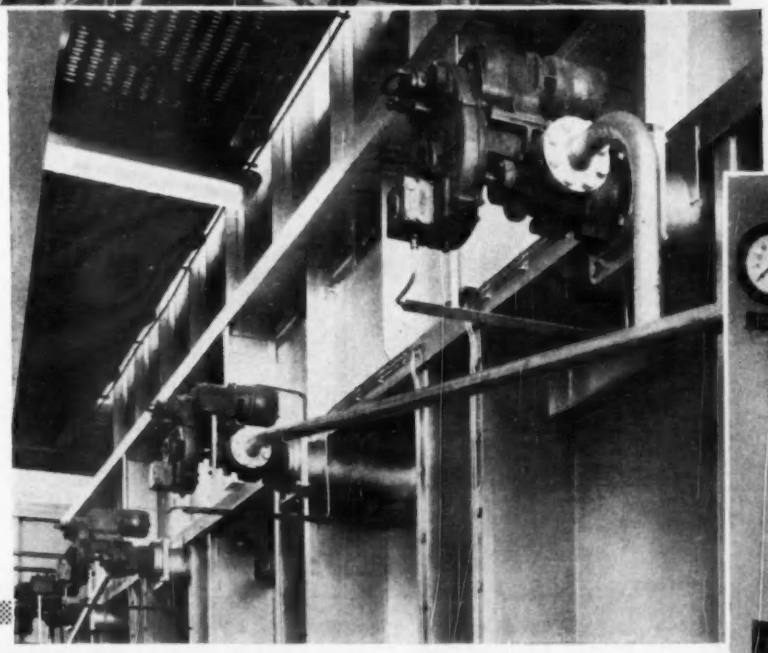
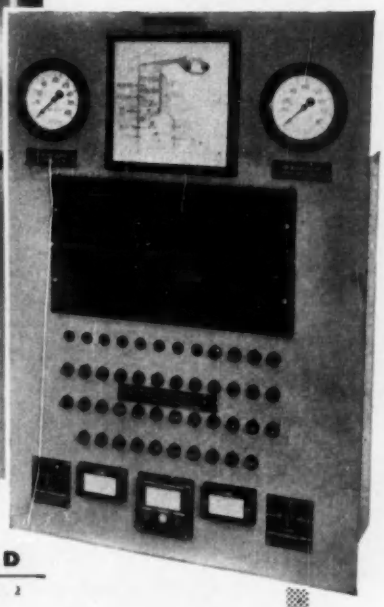
A complete range of equipment is available for every type of water-tube boiler installation.

Photographs by courtesy of Provinciaal Noord-Brabantsche Electriciteits Maatschappij



Rotary Soot Blowers

Soot Blower Cubicle



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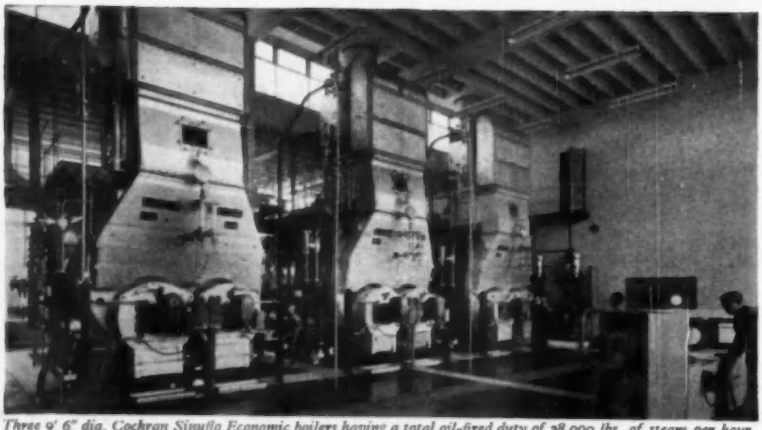
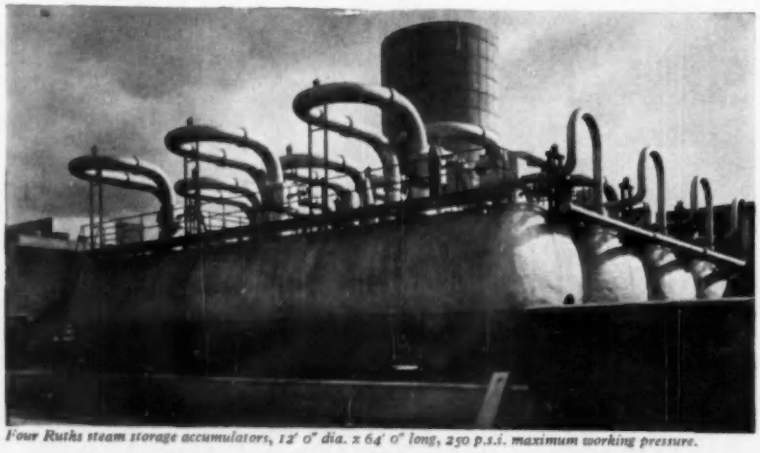
STEAM

at a rate of
ONE MILLION POUNDS PER HOUR



Three 9' 6" dia. Cochran Sinuflo Economic boilers having a total oil-fired duty of 38,000 lbs. of steam per hour at 250 p.s.i.



Four Ruths steam storage accumulators, 12' 0" dia. x 64' 0" long, 250 p.s.i. maximum working pressure.

Steam at the rate of one million pounds per hour is supplied for test purposes at the works of Bristol Aero-Engines Limited by Sinuflo Economic boilers and Ruths steam accumulators made by Cochran & Co., Annan, Ltd. At this high rate of steam flow, no pressure drop is reflected back to the boilers and no change is necessary in the boiler firing rate. Similar plants, usually much smaller, are applicable to any steam-using industry where severe fluctuations in steam demand present a problem.

SINUFLO ECONOMIC

COCHRAN BOILERS

RUTHS ACCUMULATORS

Cochran & Co., Annan, Ltd., Annan, Dumfriesshire, Scotland and at 34 Victoria Street, London, S.W.1

TAS/CH.614

New Smoke Densitometer and Alarm complies fully with British Standards

The Clean Air Act of 1956 calls for limitation of the emission of dark smoke (No. 2 Ringelmann or darker). This new Lancashire Dynamo smoke densitometer and alarm is not only an economical alarm unit which will ensure compliance with the Act but, by the addition of an indicator or recorder unit, it becomes a smoke densitometer for better combustion control and lower fuel costs.

This equipment is the first of its kind to carry the British Standards Institution's "Kite Mark", which indicates independent certification of compliance with BS.2740/56 or, plus the appropriate indicating instrument, with BS.2811/57.

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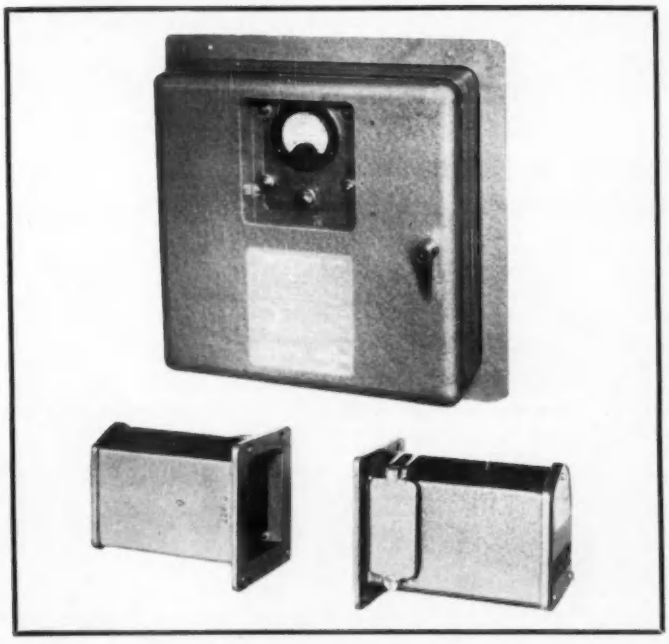
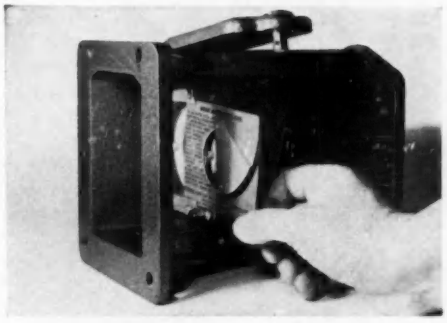
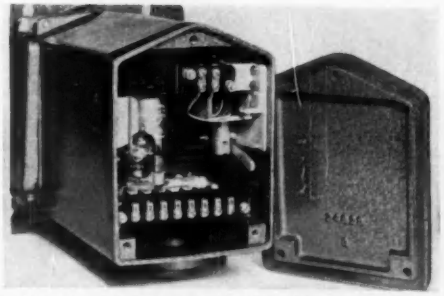
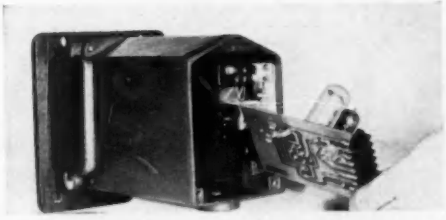
- **WEATHERPROOF CAST IRON HEAD UNITS WITH STAINLESS STEEL FITTING AND EASY ACCESS FOR LENS CLEANING.**
- **FULLY SERVO STABILISED LIGHT SOURCE PLUS "FAIL TO ALARM" CIRCUITS FOR CONSISTENT OPERATION.**
- **FULL RANGE OF ACCESSORIES INCLUDING CHIMNEY AND FLUE FITMENTS, INDICATORS, RECORDERS, ALARM BELLS AND HORNS, LENS CLEANING BLOWERS, SPECIAL CABLING AND MANY OTHERS.**

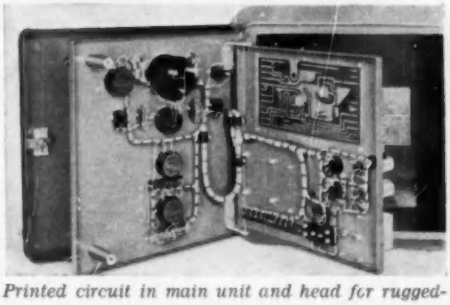






Calibration check by manual insertion of check slide or, in lower illustration of head with remote standardising unit, by push button from main unit.





Printed circuit in main unit and head for ruggedness. Head unit circuit easily removed without disturbing mounting of unit on stack.

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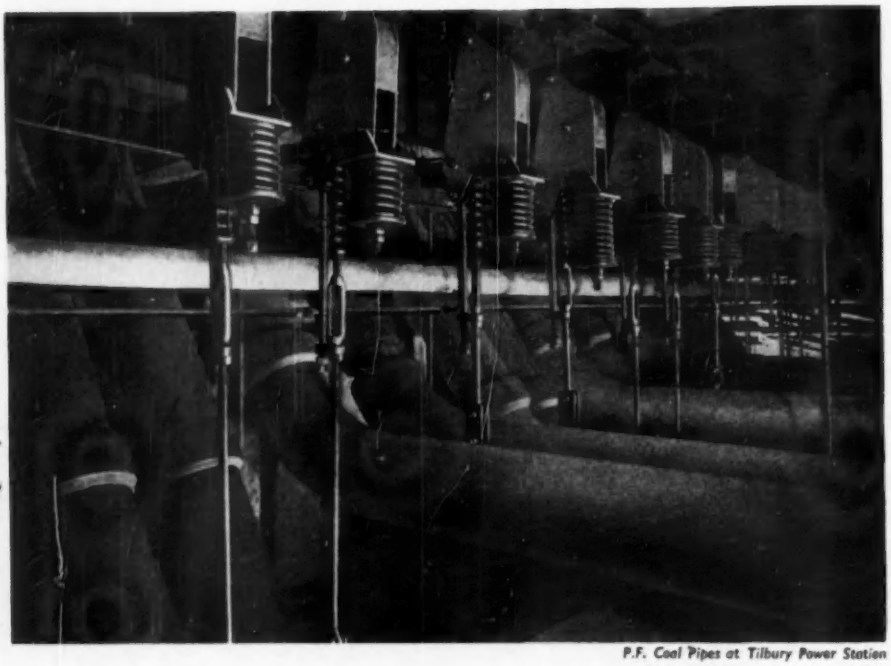

P.F. Coal Pipes at Tilbury Power Station
Photograph by courtesy of the C.E.A.

For loads up to 4 tons and pipe movements up to 18".

High-pressure steam piping is subject to wide variations in temperature, which produce considerable expansion and contraction. Unless the pipe supports can absorb and compensate for this movement, severe stresses are set up which may result in fracture. The " Con-Ten " Pipe Support is designed to cradle any type of piping with constant tension under all conditions, throughout the range of movement. " Con-Ten " is installed, with eminently satisfactory results, in power stations, oil refineries, chemical and industrial plants throughout the world.

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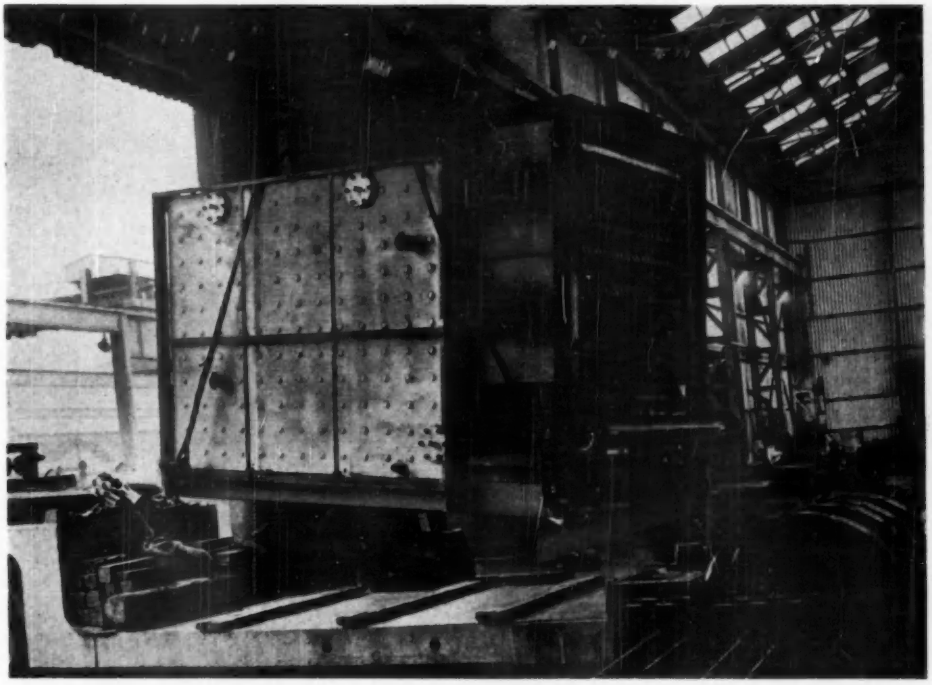

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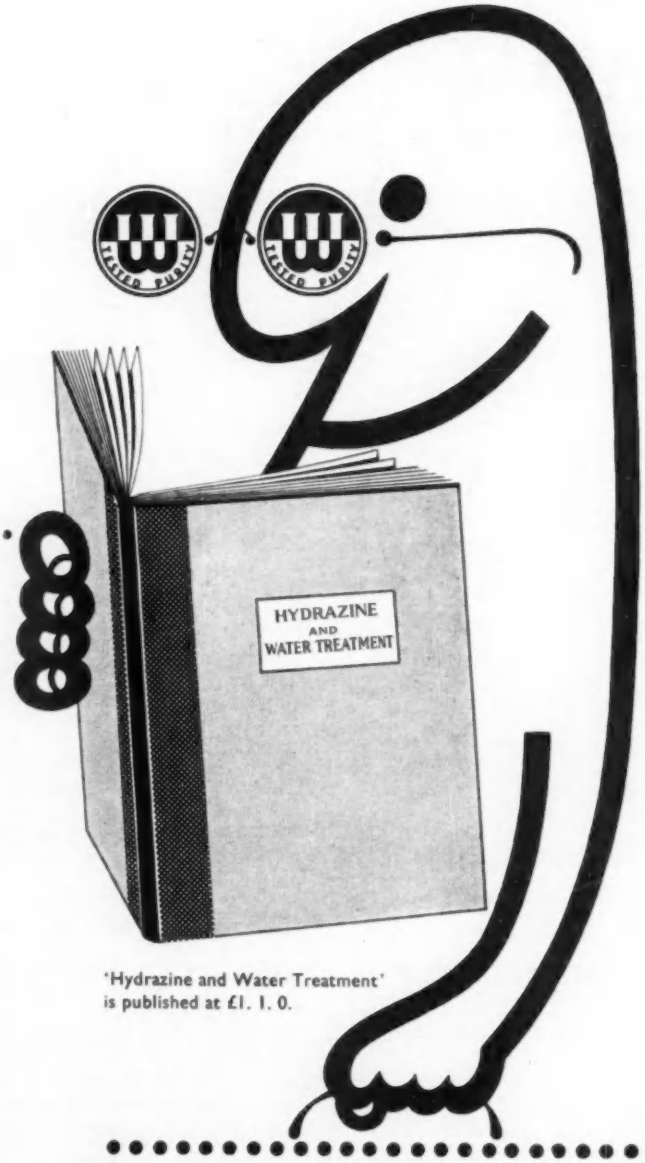

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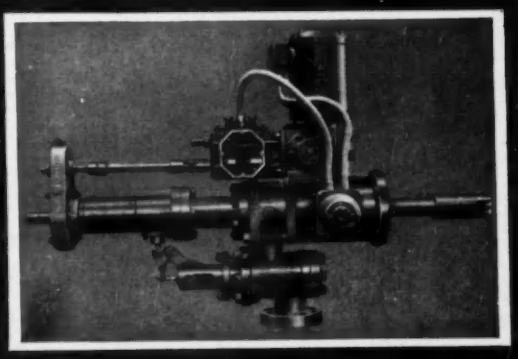
UNIFIED LECTRAMEK CONTROL SYSTEM

most efficient yet devised.

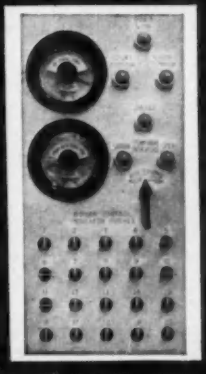
Considerable savings in initial cost and valuable boiler room space have been achieved by this new system of electrical control which works in conjunction with the Clyde Lectramek Soot Blower * - the original blower employing a uni-directional motor. Control is exercised from a small panel which indicates all essential information to the operator.

Further information is given in our publication No. CBL. 1954 which will be supplied on application.



THE BLOWER: The complete operating cycle is in one motion and is driven through a compact mechanism by a non-reversing motor. When the operating shaft is rotated, the nozzle advances, the steam ports open and, at the same time, rocking motion is automatically transmitted to the nozzle. The uni-directional motor eliminates the bulky contactor gear used with reversing motors and reduces electrical maintenance by being of simpler and more rugged construction.

The reversing motion is achieved *mechanically* on all Lectramek blowers. A limit switch mounted on the gear box and connected to the starter regulates the stopping, starting and number of strokes.



AND THE CONTROL PANEL Simple controls to operate the automatic sequence are grouped on this small unit which takes up little space on the main boiler control panel.

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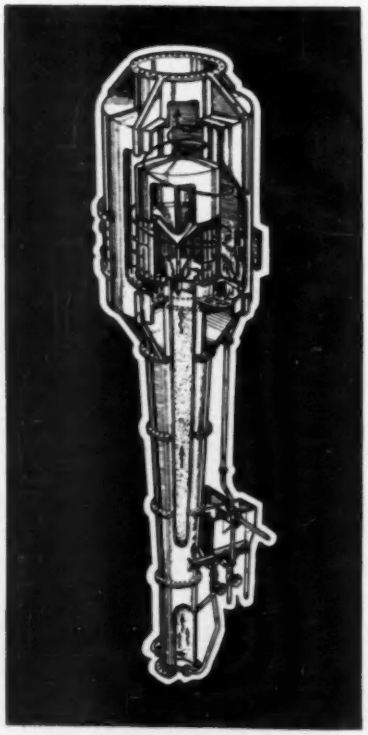

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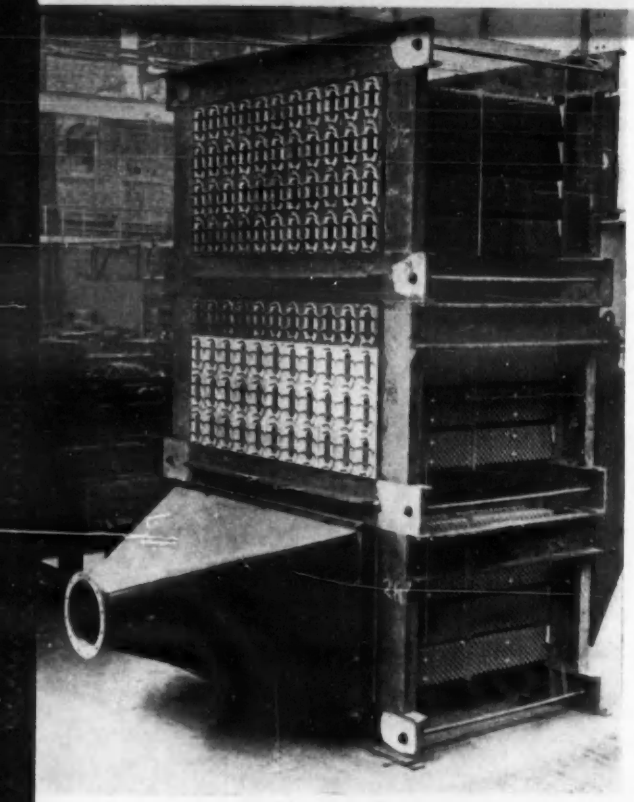

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LEFT AND ABOVE LEFT: *Newton Needle type recuperators.*
RIGHT: *Inka tube bundle being lowered into position.*

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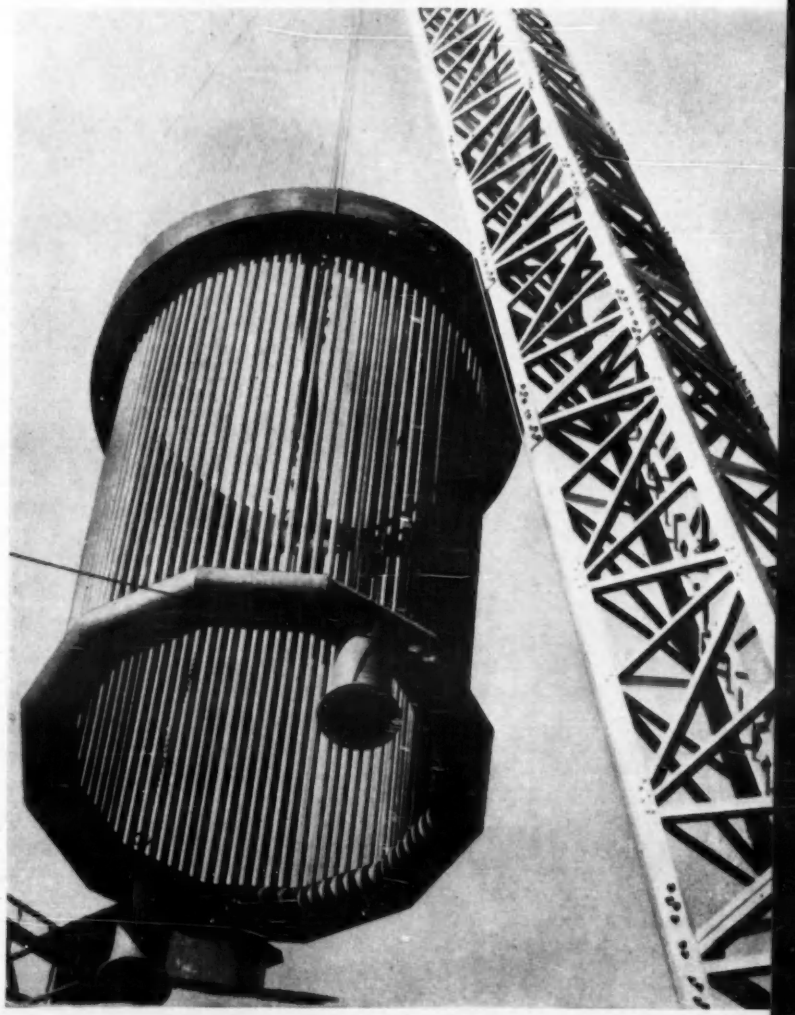
ENGINEERING DIVISION



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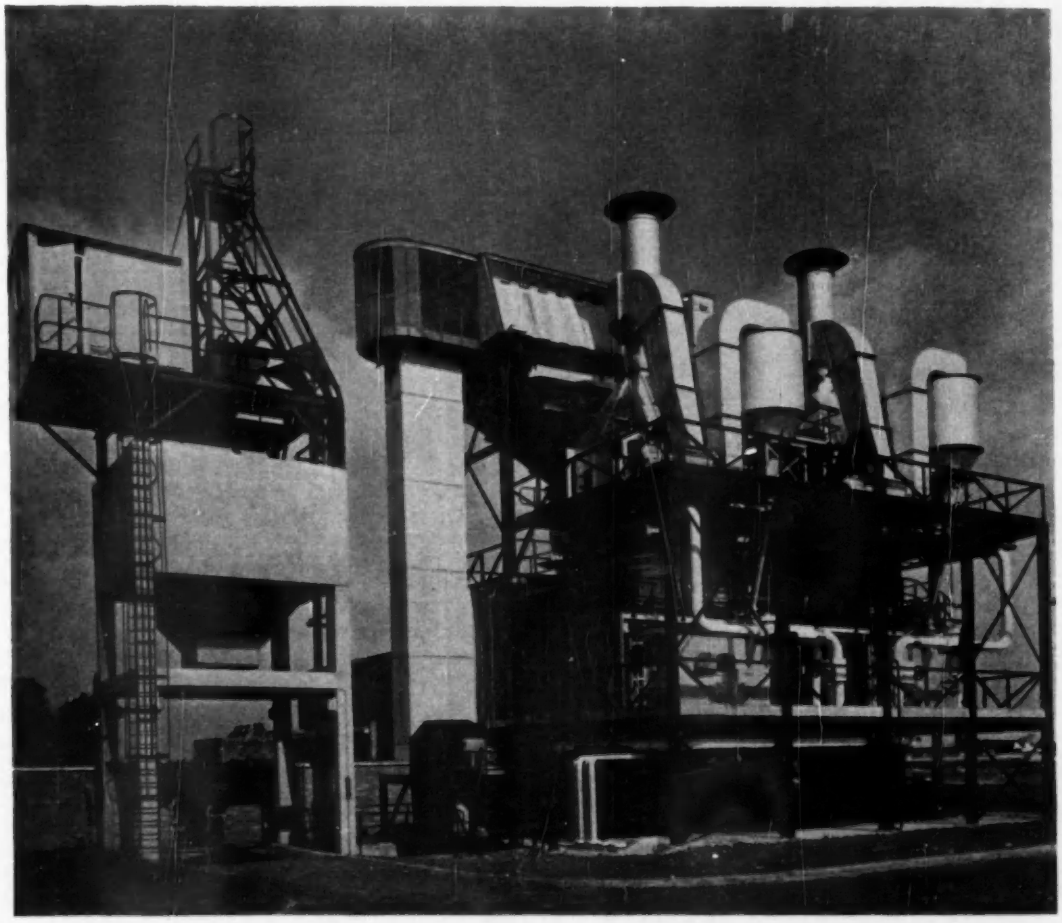

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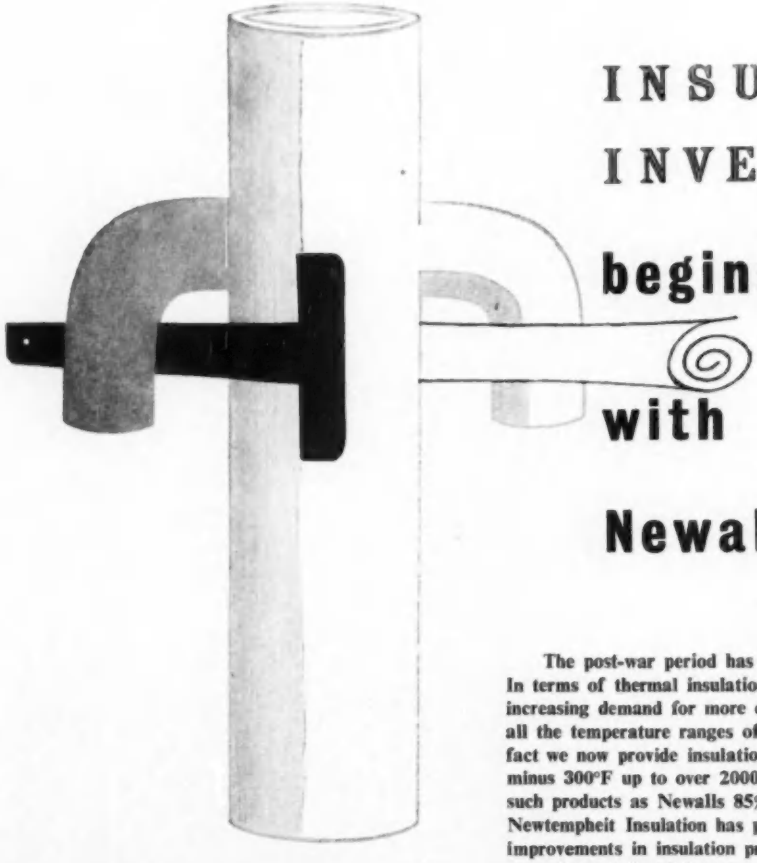

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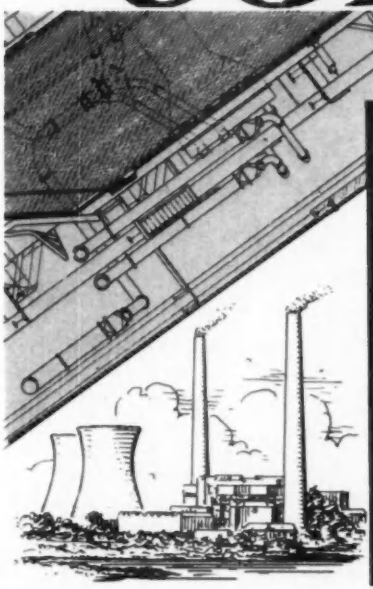

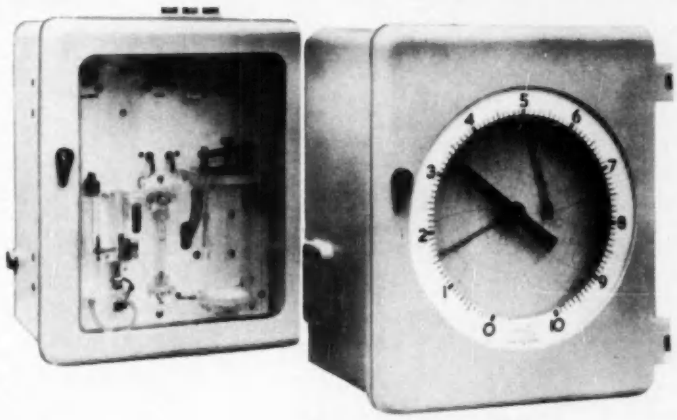

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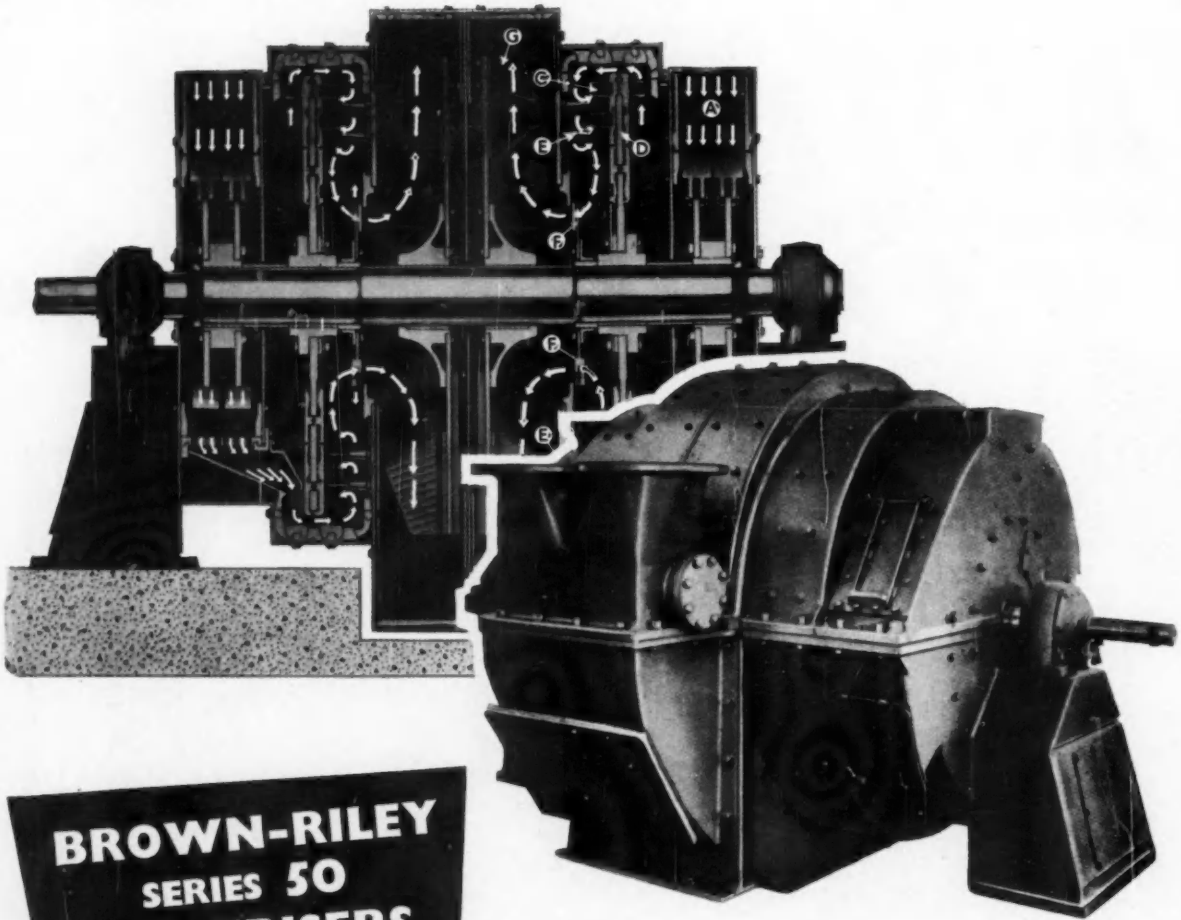

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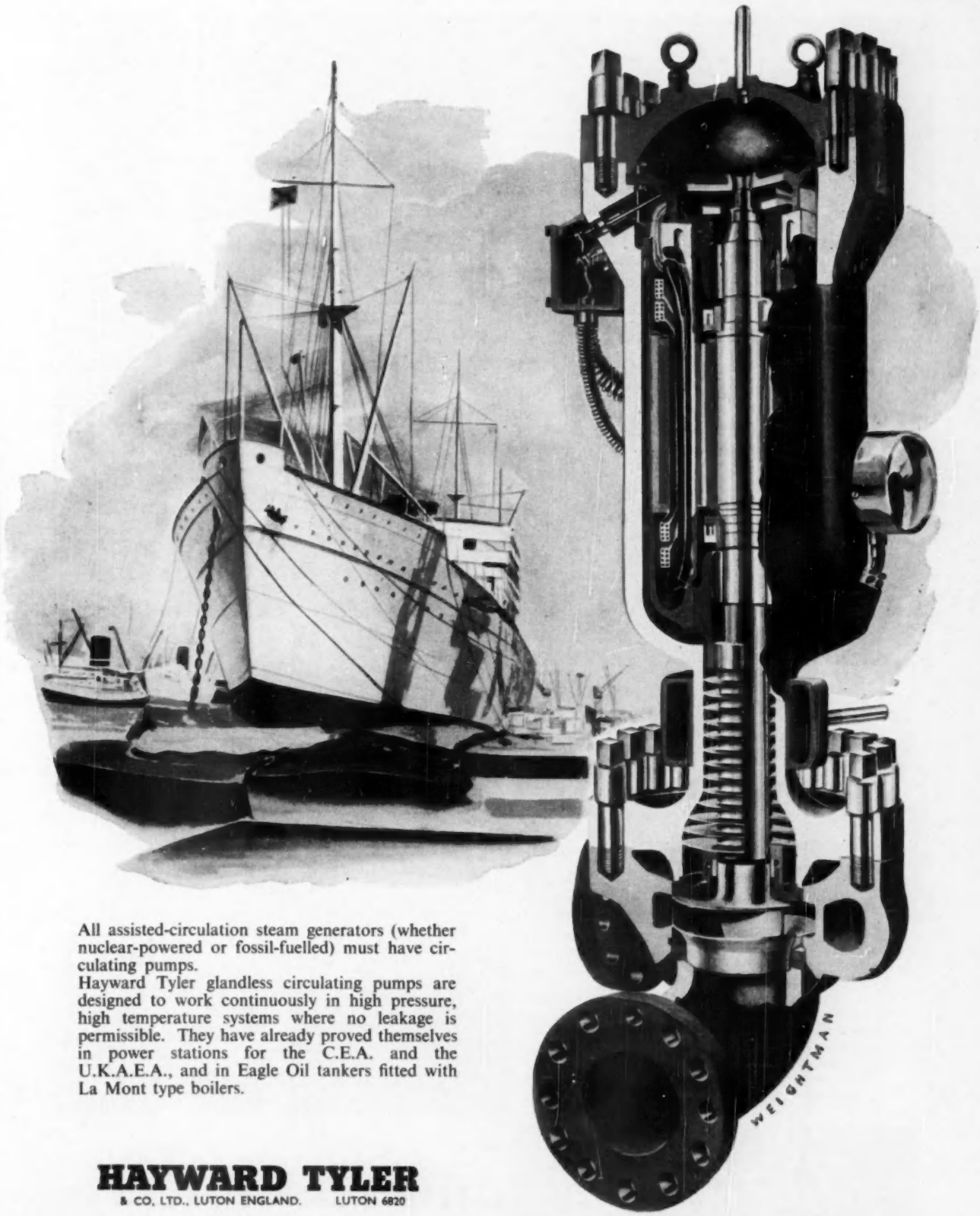

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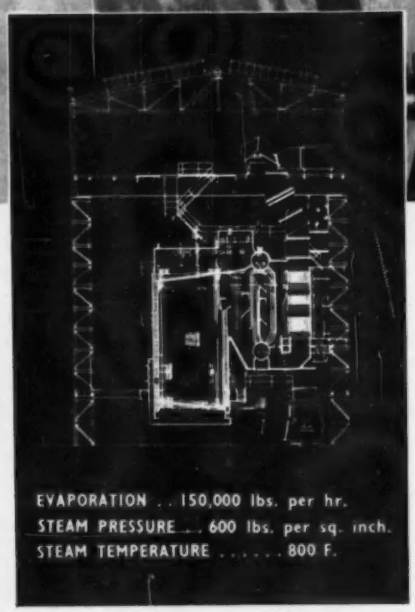

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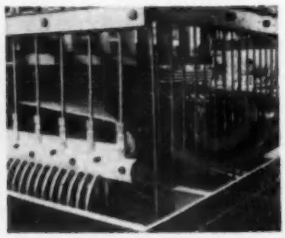

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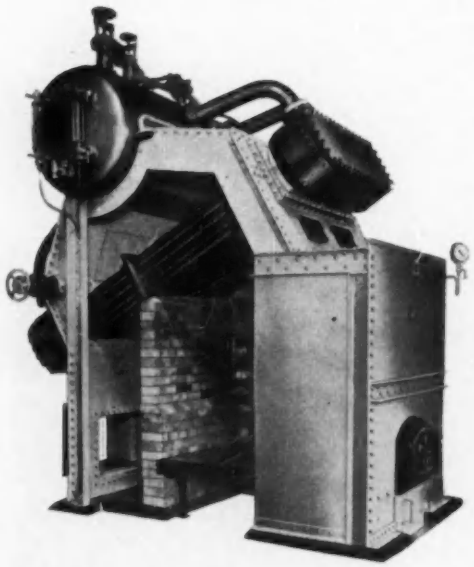

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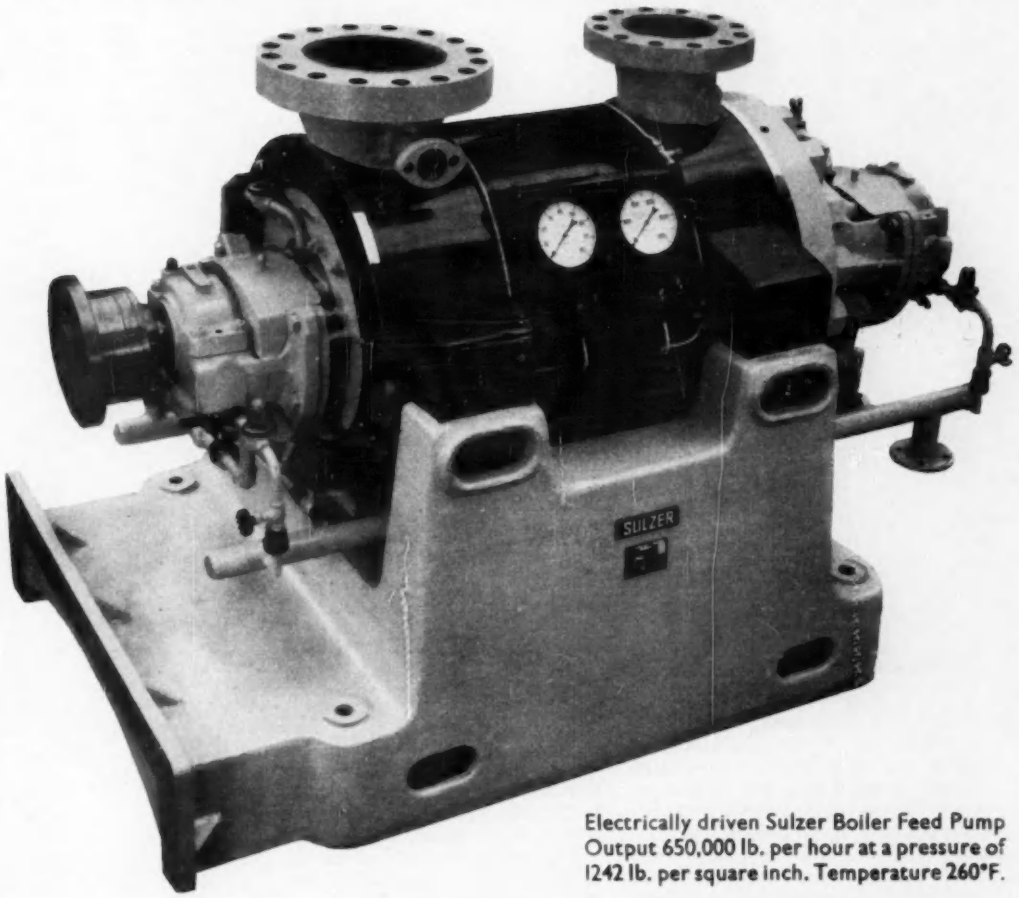

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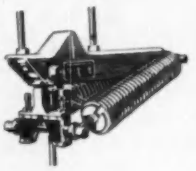

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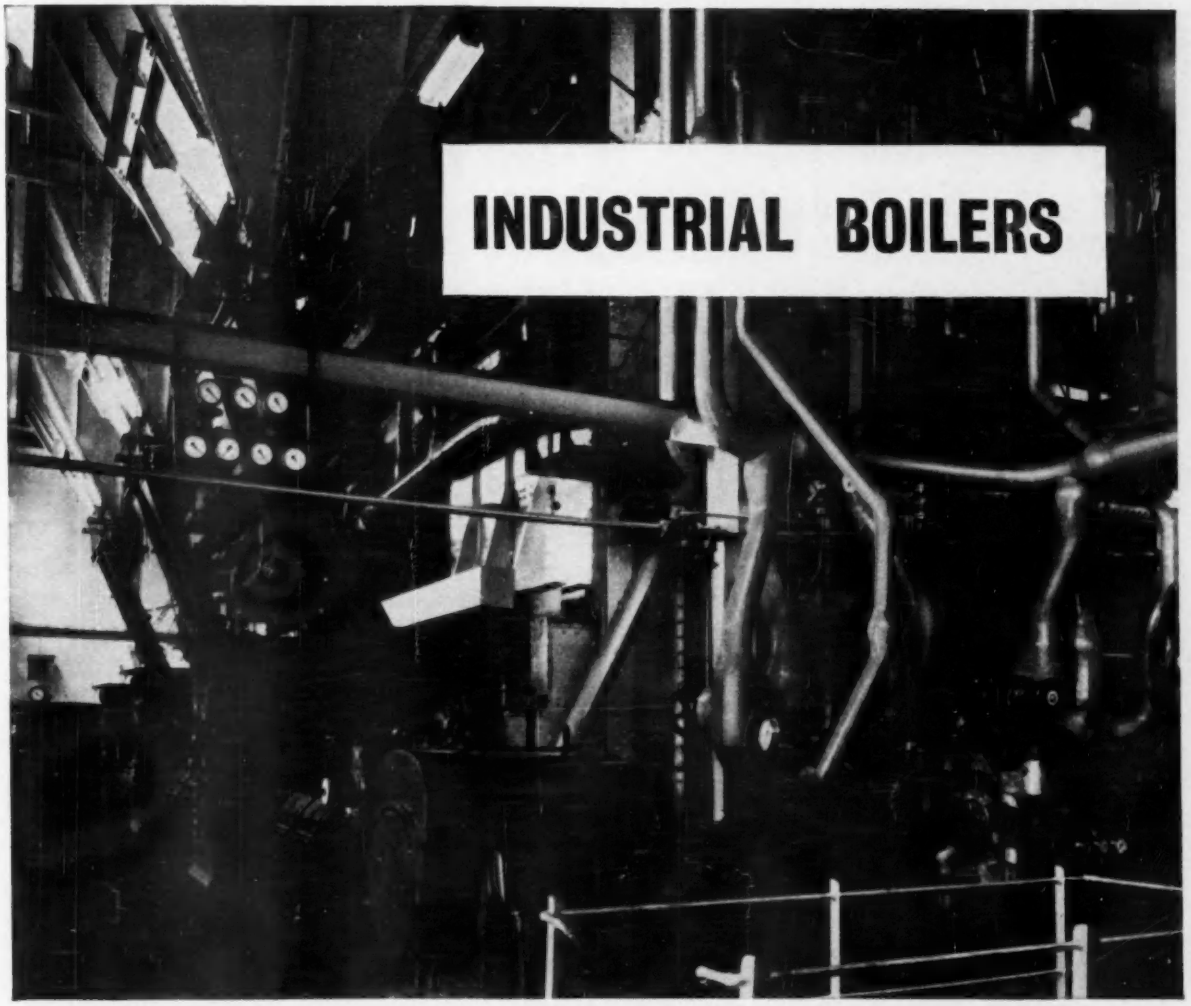

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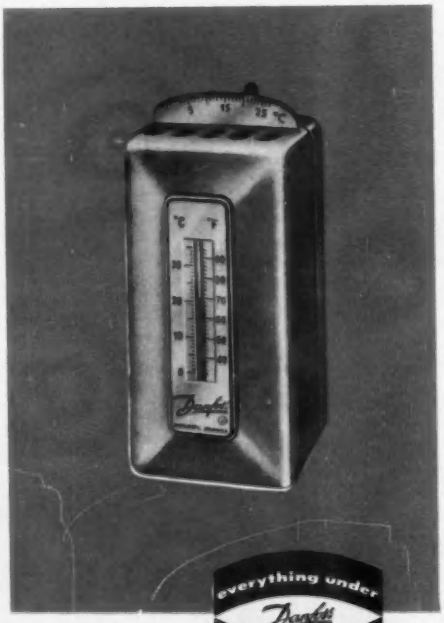

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Engineering and BOILER HOUSE REVIEW

THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

APRIL 1958

VOLUME 73. No. 4

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The Editor will be glad to receive and consider original contributions, correspondence, etc., of a suitable nature for publication. Stamped and addressed envelopes should be enclosed for the return of any matter considered unsuitable

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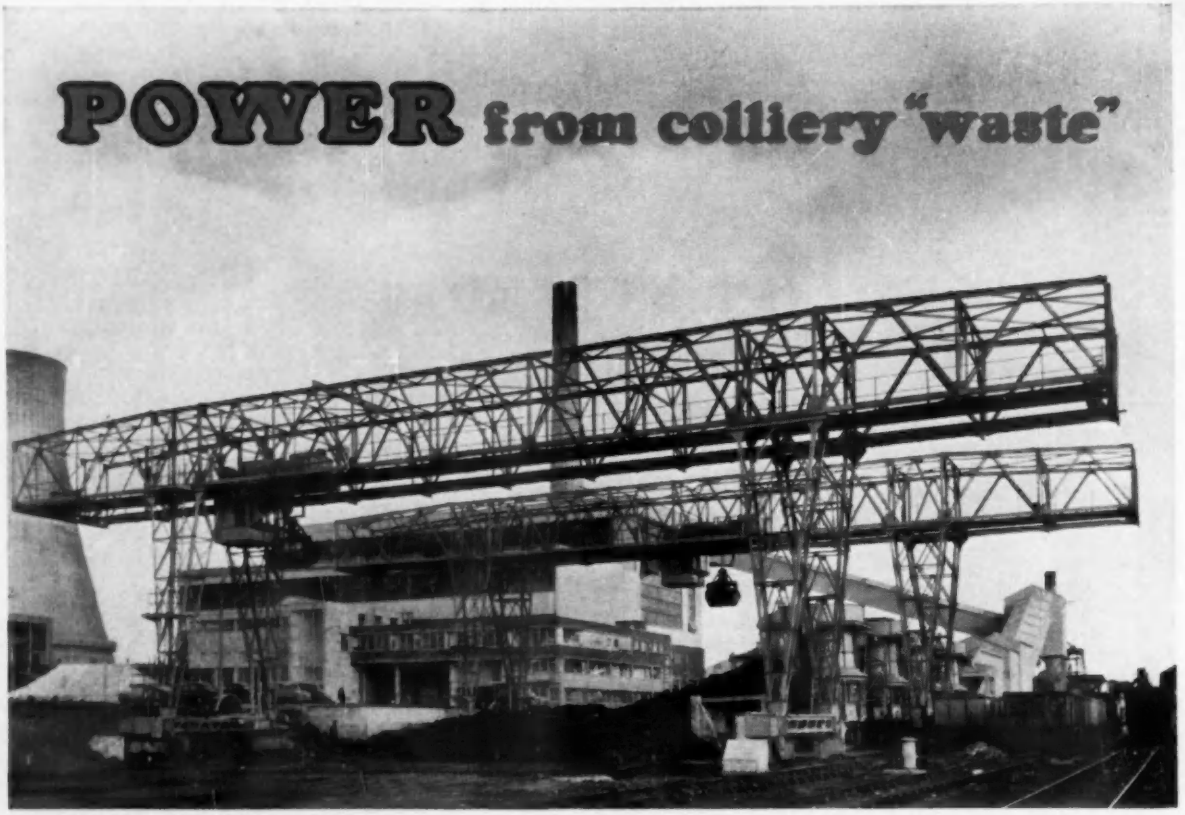
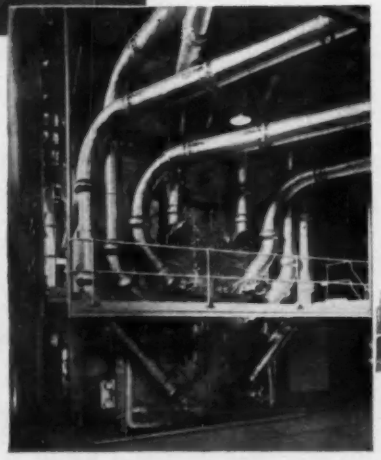


Barony power station, showing Babcock cranes, rotary hoppers and fuel conveyor system.

Line of Babcock rotary hoppers for handling slurry to the drying and pulverizing mills feeding the boilers.



P.F. burners and fuel piping on one of the boilers.

The whole of the boiler plant for the new Barony power station (South of Scotland Electricity Board), comprising four 150,000 lb./hr. pulverized-coal-fired boilers, and the whole of the coal and ash handling equipment, are of BABCOCK design and manufacture.

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FUTURE DEVELOPMENT OF NUCLEAR POWER

THE rapid progress which has been made by Great Britain in the development of nuclear power for peaceful purposes was discussed on March 18th, by Sir John Cockcroft in this year's James Forrest lecture, which he delivered at a meeting of the Institution of Civil Engineers. In his opening remarks Sir John described some of the advances that have been made since the publication, some three years ago, of the Government White Paper setting out provisional plans for the construction of nuclear power stations capable of generating 1,500 to 2,000-MW of electricity by 1965. These plans were based on a conservative forecast that improvements in reactor design would possibly enable the output from the initial group of C.E.A. stations to reach a figure of 100-MW or even 200-MW, compared with the 70-MW of Calder Hall.

Subsequent research and development work has made possible a considerable increase in the size of the gas-cooled graphite-moderated reactor and correspondingly, an increase in the amount of uranium fuel in each reactor. Furthermore, by raising the temperature of the fuel element surface from 410 to 425 deg. C., as the result of a 50 per cent. increase in the pressure of the CO_2 coolant, and by incorporating improvements in the heat transfer surface, the amount of heat that can be extracted from each ton of uranium has been more than doubled. By incorporating improvements such as these in the design of the plant for the first four stations now being built for the Electricity Board, outputs of 275 to 500-MW have been allowed for, instead of the 100-MW or 200-MW envisaged in the White Paper. Thus, the overall programme has been increased to between 5,000 and 6,000-MW.

So much for progress to date. But what will continued progress achieve in the immediate future ? Obviously there will be considerably greater outputs per reactor. Even now it is possible, as pointed out by Mr. A. L. G. Lindley of the General Electric Company in a recent speech which he made at Erith, to construct a single reactor capable of a net electrical output of 400-MW. Therefore a two-reactor station would have an output of 800-MW. What effects are the increased outputs of these larger reactors likely to have on the nuclear power programme of this country ? It is obvious that a lesser number of nuclear power stations will be needed to meet the requirements of the current programme. In addition to the four (Berkeley, Bradwell, Hunterston and Hinkley) already ordered, and whose collective output will be 1,400-MW, only another six 800-MW stations instead of the eighteen or twenty stations originally allowed for in the White Paper, would be needed to satisfy the required output of 6,000-MW by 1965. This would result in a very considerable reduction in the cost per MW of output, and also of the cost per unit sent out—thus closing the gap between the cost per unit of nuclear power and that of conventional power.

As regards future reactor developments, it may be remembered that the 1955 White Paper suggested that the second stage of the U.K. nuclear power programme might allow for the use of liquid-cooled reactors. In this connection, Sir John Cockcroft explained in his lecture that during the past three years at Harwell they had carried out a detailed design study on the sodium-graphite reactor, and a research study on the pressurised-water reactor. The former has the potential attraction of attaining high outlet coolant temperatures—of the order of 500 deg. C.—with correspondingly high thermodynamic efficiencies of the order of 37 per cent. The system pressure is low because of the low vapour pressure of liquid sodium, whilst heat ratings of at least 10-MW per ton seem achievable with a cluster of small diameter uranium rods of uranium oxide fuel elements. So with these parameters, reactors giving at least 400-MW of electrical output would be possible. To set off against these advantages, the neutron economy of the reactor is poor, partly because of the absorption of neutrons by the sodium, and enriched uranium fuel of about twice the natural U 235 content would be required. Thus the cost of fuel would be high. More important still are the compatibility and safety problems of the reactor. Liquid sodium is not compatible with graphite, so they would have to be kept apart by pressure tubes surrounding the fuel elements. These tubes would have to be of zirconium or an alloy of zirconium, since steel absorbs too many neutrons. Finally, there is the safety and maintenance problems associated with liquid sodium. The possible economic advantages of the sodium-graphite reactor do not, therefore, seem to outweigh its serious development and maintenance problems.

The pressurised-water and boiling-water reactors are the mainstay of the U.S.A. and Russian nuclear power programmes at present, so they cannot be lightly dismissed. The water-moderated reactors, however, have the disadvantage that enriched uranium fuel must be used. This fuel produced in any European country would be much more expensive than in the U.S.A. owing to the enormous scale of the U.S. diffusion plants—each of them uses 2,000-MW of electricity, the cost of which is only about one-third that of electricity to a European diffusion plant.

In this country two future lines of development are being investigated. First, the development of the gas-cooled graphite-moderated reactor to the maximum of its considerable potentialities. Second, the possible advantages of a change to heavy water as a moderator. But the present phase of development in this country is already aimed at reducing the cost of nuclear power stations, to produce electricity more cheaply than by conventional means.

Points and Pointers

INSTITUTION OF ELECTRICAL ENGINEERS

More than one speaker at the recently held annual dinner of the Institution of Electrical Engineers in London was concerned with problems of education and training. Lord Adrian, Master of Trinity College, and Vice Chancellor, University of Cambridge, who proposed the toast of the Institution of Electrical Engineers, spoke of the need of keeping a balance between the arts and sciences in the attempts that were being made to train more students. Much had been said in the past about the need for science students to appreciate the humanities, but was it not equally important that arts students should have a sound background of scientific knowledge and of the fundamental ideas that lay behind most of the technological advances of today? Mr. T. E. Goldup, the president of the Institution of Electrical Engineers, who replied, touched on a more immediate problem when he referred to the Diploma in Technology and the difficulties created by the wide variations in sandwich courses devised by different technical colleges. This problem had been the subject of recent discussion between the I.E.E. and the Ministry of Education and a joint statement was soon to be issued. A main feature in the new pattern of development, said Mr. Goldup, would be a two-year sandwich diploma course for technicians, to follow the Ordinary National Certificate. In future, that certificate might lead either to one of these new courses for technicians or to a Higher National Certificate, or a Higher National Diploma, or a Hives' course. Apart from the Universities it would be mainly the Higher National Diploma course to which the Institution would look for its future professional members. Mr. Goldup made it quite clear, however, that the Higher National Certificate would still provide an avenue, but an increasingly laborious one, to professional qualifications; he, personally, thought that this part-time method of progressing towards professional status was not always in the best interests of the student, particularly because of the wider and deeper field that had to be covered.

ENGINEERING APPLICATIONS OF AUTOMATION

Little more than a year ago, a number of the principal engineering institutions decided, after consultation, that the time had arrived for the establishment of an organisation to be known as the British Conference on Automation and Computation. The principal object of this organisation is to make provision for the exchange of information about the activities of the individual societies in so far as they relate to automation and computation. The organisation has now been divided into three groups, namely, engineering applications of automation; computation and automatic control; sociological and economic aspects of automation techniques. The first of these groups was formally constituted, at a recent meeting in London, as the British Group for the Engineering Applications of Automation. The principal objects of the group are to foster the development of the engineering applications of automation; to afford a common meeting ground for the adhering organisations, whereby such of their activities as fall within the purview of the group can, if so desired, be co-ordinated and extended, and to encourage and maintain liaison with the corresponding national committees of other countries. Dr. D. F. Galloway, M.I.Mech.E. (Institution of Mechanical Engineers), has been elected chairman of the group, the vice-chairmen being Mr. J. S. Brough, M.I.Mech.E., M.I.Chem.E., and Sir Walter Puckey, M.I.Prod.E., F.I.I.A. The secretarial services are being undertaken by the Institution of Mechanical Engineers, Mr. Brian G. Robbins, secretary of that Institution, having been elected honorary secretary of the group.

SECOND ATOM CONFERENCE AT GENEVA

In July last year it was announced that the British Government had accepted an invitation from the Secretary-General of the United Nations to participate in the second International Conference on the Peaceful Uses of Atomic Energy, from September 1st to 13th, 1958. The provisional agenda covers all aspects of the peaceful applications of atomic energy. The President of the Conference is to be Professor F. Perrin of the Commissariat a l'Energie Atomique de France and the Secretary-General, Dr. S. Eklund of Sweden. Arrangements for U.K. participation are being organised by an executive committee (chairman, Sir John Cockcroft; secretary, Mr. B. W. Mott) and a papers committee (chairman, Dr. B. F. J. Schonland; secretary, Dr. T. A. Hall), with a secretariat operating from the Atomic Energy Research Establishment, Harwell. The representatives on the Committees have been drawn from the U.K. Atomic Energy Authority; the electricity authorities; industry; the Medical Research Council; universities and other organisations. Two exhibitons will be held in Geneva during the Conference. The first of these will be a scientific exhibition, and the other will be commercial. The British Section at the latter is being orgnaised by the Nuclear Energy Trade Associations' Conference, which represents all major British firms concerned with atomic energy. More than 50 British firms will be exhibiting in this section, which will alone cover more than 30,000 sq. ft., and will include an exhibit of 3,500 sq. ft. by the Atomic Energy Authority. The U.K. Delegation is expected to consist of five delegates, about 250 advisers and about 250 observers, the advisers being drawn primarily from among the authors of papers. The leader of the U.K. delegation will be Sir John Cockroft, Member for Scientific Research of the United Kingdom Atomic Energy Authority. The demand for observer passes has already been very high and to help the organisers to arrange a fair distribution, it would be most valuable if all people interested in attending the Conference as observers would apply for passes as soon as possible, and in any case not later than April 19th, 1958. Representatives from industrial firms who are working in the atomic energy field should apply to

Mr. M. H. L. Whitehouse, Nuclear Energy Trade Association's Conference, 32, Victoria Street, London, S.W.1, and all others to Mr. J. C. Walker, United Kingdom Atomic Energy Authority, 11, Charles II Street, London, S.W.1.

TECHNICAL EDUCATION AND TECHNICAL ADVANCE

Russia, and to some extent the U.S.A., were still pioneering the development of natural resources on a continental scale within their own boundaries, said Mr. Geoffrey Lloyd, Minister of Education, speaking at the annual dinner of the Association of Supervising Electrical Engineers in London on March 15th. "Increasingly," said Mr. Lloyd, "the development of world natural resources will result in other countries making for themselves many of the products they now buy from Britain. Our future must therefore depend more and more on our ability to stay permanently in the vanguard of technical advance, so that we can offer to the world products more highly developed than those which they are making for themselves." The Minister said that the electrical industry were pioneers in the development of this new approach to the conquest of world markets. And, to them, the link between technical education and technical advance had long been self-evident. "Electrical engineering," he said, "accounted for 2,000 out of the 9,000 Higher National Certificates awarded last year, mainly to part-time students." But the industry were also amongst the first to realise that the complexity of modern technology made it increasingly difficult for many students to go on for professional qualifications by part-time study alone. "There are now," he said, "some 40 full-time and sandwich courses in technical colleges approved for the new Diploma in Technology. The largest single group of students are the electrical engineers, with an enrolment of about 500 out of a total of nearly 1,400. The first Diplomas will be awarded this summer to students in Electrical Engineering at the Birmingham College of Advanced Technology." The Minister also congratulated the electrical industry on its development of courses for technicians and craftsmen. Industry, generally, had not yet fully grasped that it was not enough to put forward a general demand for more and better technical education. It was much more important to follow the lead of the electrical industry in identifying the jobs for which specific types of training were required, and then to co-operate with the technical colleges in setting up tailor-made courses.

THE BEAMA CATALOGUE

The fourth edition of the BEAMA Catalogue—the biggest trade catalogue in the world—was introduced at a special Press conference held on Thursday, March 20th, at the Connaught Rooms, London. The principal speakers at this Conference were Mr. John K. Vaughan-Morgan, M.P., Minister of State, Board of Trade, and Mr. J. O. Knowles, chairman of the Council, British Electrical and Allied Manufacturers' Association. This latest edition of the catalogue, which gives details of more than 1,300 product groups in 962 pages, contains a very comprehensive trade directory and buyers' guide, and includes a glossary in five languages. The issue has been timed to coincide with the opening of the 1958 Brussels World Exhibition this month, where the largest collective exhibit in the British Industry Pavilion will be that of the British electrical and allied industry. Fifteen thousand copies of the catalogue will be distributed free to selected buyers all over the world, and additional copies will be available at Brussels for distribution to potential customers. There will also be 16,000 supplementary volumes of the separate sections to meet the more specific requirements of those concerned with particular products. This fourth edition includes much information about nuclear engineering which has come so rapidly to the fore since publication of the third edition of the Catalogue in 1955. The British electrical and allied manufacturing industry is one of the two largest exporting industries in this country and this catalogue, which has been compiled by the British Electrical and Allied Manufacturers Association on behalf of its 400 firms, is recognised as the most comprehensive guide to electrical products available to home and overseas buyers.

THE BRUSSELS EXHIBITION

General satisfaction with the progress being made in the erection of the stands in the power and energy section of the British Industrial Pavilion at the Universal and International Exhibition to be held in Brussels from April 17th—October 19th, was expressed at a press conference held on March 7th in the London headquarters of the Federation of British Industries. The organisers were also confident that the exhibits would be successful and entirely worthy of the British Electrical and Allied Manufacturing Industry, that last year exported nearly £280 million worth of equipment. No less than £1,000 million worth was sent overseas during the years 1954-57. The collective exhibit in the British Industries Pavilion has been organised with the active support and co-operation of seven trade associations and about 150 individual firms. The display stand being organised by the Board of Trade and the Atomic Energy Authority will not only portray Britain's achievement in putting into operation the world's first commercial nuclear power station and the manner in which this particular type of station is being developed, but also the research now in progress on new and more efficient forms of fission reactor. The display will illustrate those aspects of nuclear power generation which are expected to lead to sales of plant and equipment for this purpose during the next 10 or 15 years. The stand of Babcock & Wilcox Ltd. will feature steam power as a major factor in economic progress, but approximately half the stand space will be occupied by a display featuring the activities of The English Electric—Babcock & Wilcox—Taylor Woodrow Atomic Energy Group, with special emphasis on the 500-MW nuclear power station being constructed at Hinkley Point by this group. The stand of the Nuclear Power Plant Co. Ltd. will consist entirely of an animated scale model of a complete 400-MW nuclear power station employing two graphite-moderated, gas-cooled reactors using natural uranium as fuel. The size of the model is such that one of the reactor buildings will be used as an office. The English Electric Company (and three of its associated companies), together with other British manufacturers of electrical plant and equipment, will feature some striking examples of the manufacturing capacity of Britain's heavy electrical industry.

Additional Power and Water for the State of Kuwait

By T. A. LYNCH, A.M.I.Mech.E.

PRIOR to 1957 the Arab State of Kuwait had the largest sea-water distillation plant in the world, with a capacity of 2,000,000 gal./day. A further distillation plant of similar capacity has now been installed, together with a power station of 40-MW initial capacity. In April, 1956, there was published in this journal an article which dealt with the then existing water and power producing plants and in this article reference was made to proposed future development. The present article describes the work subsequently carried out. Before commencing a detailed description, it may be of interest to reveal something of the background of Kuwait which is one of the smallest of the Arab territories: it has an area of some 6,000 square miles, and is situated near the head of the Persian Gulf, bounded by Irak to the north and Saudi Arabia to the south.

The wealth which provides for development in Kuwait is derived from the production of oil but, although the presence of oil was proved before the war, output of any significance had to wait until after the war had ceased. The real impetus to production in Kuwait came with the action in Abadan and the closing of the Iranian oil-fields.

The following figures show the output from Kuwait in thousands of metric tons, and also Middle East output as a percentage of world output.

Metric tons (thousands)			
1946	800	1952	37,637
1948	6,400	1953	43,286
1949	12,378	1954	47,723
1950	17,291	1955	54,756
1951	28,726	1956	54,982
		1957, Oct.	54,030

	1938	1946	1952	1954	1956
Middle East output as percentage of world output	5.7	9.4	17.0	20.0	20.4

Fifty per cent. of the oil revenue goes to the Kuwait Authorities, some £100 million per year, and it is due to the enlightened policy of the former ruler, Sheikh Ahmed al Jabir al Subah, the present ruler, Sheikh Sir Abdullah al Salim al Subah and the Kuwait Government, that the community has been provided with schools, hospitals, water supply plant, power plant and industry. It is also of interest to note that the Kuwait Government now proposes to have built in Kuwait an international airport, Class A, suitable for long distance jet aircraft.

Prior to 1950, drinking, or so called sweet water, was imported from Irak. The water was river water from the river Shatt-El-Arab and Arab dhows brought the water to Kuwait, where it was distributed in skins and supplemented with a small proportion of brackish water obtained from local wells. The only source of electric light and power was from small diesel-driven installations largely privately owned. In 1950, as part of the Kuwait Oil Company's developments some 30 miles from the town of Kuwait, there was installed a 600,000 gal./day sea-water distillation plant. It was arranged for a supply of 250,000 gal./day to be pumped to the town of Kuwait.

The Kuwait Government decided to install water and power plants in the town, and Ewbank and Partners, engineering consultants, London, having been responsible for Kuwait Oil Company's sea-water and power installations, were asked to engineer the Government projects. A site was chosen at Shuwaikh, two miles along the coast from the town of Kuwait.

The first plant (A) was a distillation plant with a capacity of 1,000,000 gal./day, and there was also a small power plant, mainly for house service requirements. The installation included ten Westinghouse triple-effect evaporators each of 100,000 gal./day capacity, and three 80,000 lb./hr. Babcock & Wilcox F.H. type integral furnace boilers. Construction was commenced in 1951 and the first evaporator unit was commissioned in March, 1953. A second distillation plant (B) was authorised, and the first unit was commissioned in February, 1955. It was of similar design to plant (A), but the evaporators were supplied by G. & J. Weir Ltd. Constructional work on the first power station (A) was started in February, 1953, and the first turbo-alternator was commissioned in August, 1954. The installed capacity is 30-MW from four 7.5-MW Westinghouse pass-out turbo-alternators.

The demand for still more water and electric power is not only an indication of the increased number of consumers, but also greatly increased consumption per consumer. Among the major factors which have brought about the increased demand for power are air conditioning during the summer, and space and water heating during the winter. The temperatures in Kuwait vary during the year between a maximum of 170 deg. F. (shade 120 deg. F.) and a minimum below freezing. Humidity is normally lower than at most other places in the Persian Gulf, but during the period November to January figures over 90 are common. Sea temperatures vary between 55 deg. F. and 90 deg. F. and all condenser equipment is rated accordingly.

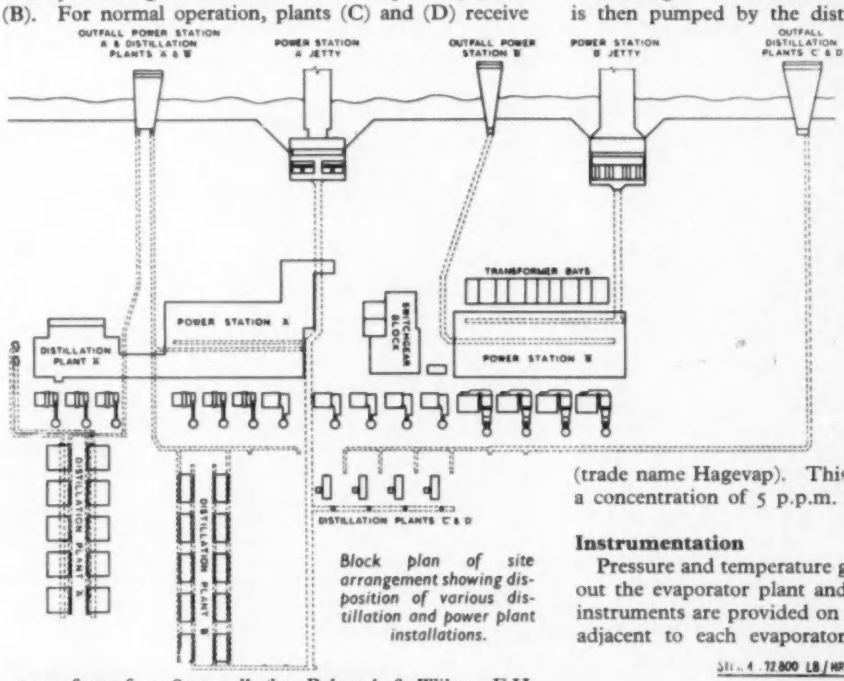
A census of the population has been carried out in Kuwait for the first time, and the preliminary figures published in February, 1957, are as follows :—

	Male	Female	Total
Kuwait Town	62,478	36,960	99,438
Environs of Kuwait	13,691	6,343	20,034
Other areas of Kuwait	55,753	30,952	86,705
Total number of residents of Kuwait	131,922	74,255	206,177

NEW INSTALLATIONS

Sea-water distillation plant

Dealing first with the distillation plants (C) and (D), these have a capacity of 2,000,000 gal./day bringing the total installed capacity on site to 4,000,000 gal./day. The first of the new distillation units was commissioned in October, 1957, and the remaining three units in January and February this year. The installation for (A) and (B) included seven 80,000 lb./hr. boilers in line from east to west. The new installation is continued in the same line and the L.P. steam, H.P. feed and L.P. feed system ring mains are connected to plants (A) and (B). For normal operation, plants (C) and (D) receive steam from four 80,000 lb./hr. Babcock & Wilcox F.H. type integral furnace boilers, but as the ring main is common to plants (A), (B), (C) and (D), steam is available to any evaporator from any of the total of 11 boilers.


OUTFALL POWER STATION A & DISTILLATION PLANTS A & B
POWER STATION A JETTY
OUTFALL POWER STATION B
POWER STATION B JETTY
OUTFALL DISTILLATION PLANTS C & D
TRANSFORMER BAYS
POWER STATION A
SWITCHGEAR BLOCK
POWER STATION B
DISTILLATION PLANT A
DISTILLATION PLANT B
DISTILLATION PLANTS C & D

Block plan of site arrangement showing disposition of various distillation and power plant installations.

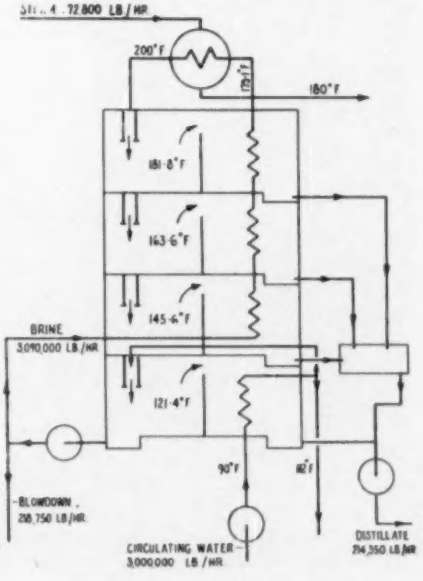
Evaporators

The evaporators for the new installations (C) and (D) were supplied by the Westinghouse Electric International Company. They differ markedly from the distillation plants (A) and (B) in that they are of the multi-stage flash type. The individual capacity of 525,000 gal./day makes these evaporators the largest of their type for land use. The evaporator is a tall structure made up of four steel boxes placed one above the other, the overall dimensions of this structure being 28-ft. high, 30-ft. long and 10-ft. wide. The accompanying diagram shows the salient details of the design and is drawn in the form of an end view. Each of the stages is divided longitudinally into a flash chamber on the left-hand side and a condensing section to the right. Sea-water is continuously circulated through the condenser section of the bottom or fourth stage. The brine re-circulating pump lifts the brine through the condenser sections of the third, second and first stages successively. On leaving the first stage the brine is passed through a heater mounted on top of the evaporator. The brine is heated therein to 200 deg. F. by steam which is admitted to the heater shell at 10 lb./sq. in., total heat being 1,166 B.Th.U./lb. After the heater, the brine is admitted to the flash section of the first stage where it flashes at 181.8 deg. F. The flash vapour rises and enters the condenser side. The process continues through the second, third and fourth sections. The product from the first, second and third condenser sections is taken through the make-up evaporator condenser and thence to the condenser section of the fourth stage. The combined product of all four stages is then pumped by the distillate discharge pump into storage reservoirs and thence into the potable water distribution system, a quantity of 218,750 lb./hr. being discharged as blow-down. A connection is taken from the main C.W. circulation which supplies feed make-up into the fourth-stage brine section.

To prevent the formation of undesirable scale, the feedwater is treated with a proprietary mixture of chemicals consisting of sodium tripolyphosphate and lignin sulphonic acid derivatives (trade name Hagevap). This mixture is administered at a concentration of 5 p.p.m. of the feedwater.

Instrumentation

Pressure and temperature gauges are installed throughout the evaporator plant and, in addition, the following instruments are provided on an instrument panel located adjacent to each evaporator unit. These instruments



Flow diagram for one of the 525,000 gal./day Westinghouse evaporator units.

indicate the temperature of the brine entering and leaving each of the condenser stages. Other instruments record the amount of distillate output, sea-water make-up, boiler feed make-up, and distillate conductivity.

Boiler plant (Distillation plants C & D)

The four new Babcock & Wilcox boilers are identical to those previously supplied, the m.c.r. being 80,000 lb./hr.

The boiler furnaces are designed to burn oil or natural gas, the latter being the normal fuel used—it having the following analysis.

Methane (per cent.)	74.9	Propane (per cent.)	4.5
Ethane (per cent.)	11.8	Nitrogen (per cent.)	2.8
CO_2 (per cent.)	2.5		

Gross calorific value is 1,195 B.Th.Us./cu. ft.

The characteristics and analysis of the gas oil are as follows :—

Specific gravity at 60 deg. F.	830-850
Distillation IBP deg. C.	210-220
Recovery at 300 deg. C. (per cent.)	60-85
FBP deg. C.	335-380
Flash point PMC deg. F.	204
Total sulphur, wt. (per cent.)	1-1.3
Cloud point deg. F. max.	10
Calorific value B.Th.U./lb. (gross)	19,500
Carbon residue (Conradson) wt. (per cent.)	0.1
Diesel index min.	60
Viscosity Redwood 1 at 100 deg. F. sec. max.	50

The boilers are designed for a working pressure of 210 lb./sq. in. and a temperature of 720 deg. F. at the superheater outlet, when fired with natural gas. With oil firing the design steam temperatures are 700 deg. F. at m.c.r. and 670 deg. F. at 80 per cent. load. Feedwater is supplied at 210 deg. F.

Each boiler has a heating surface of 9,530 sq. ft., and has an upper and lower drum connected by rows of generating tubes. The integral furnace is formed by an extended screen of water tubes to one side of the boiler, and this forms the roof and outer wall of the furnace. This screen is fed from the lower drum through the tubes forming the bottom of the furnace, and is connected back into the top drum. The end walls are similarly treated ; the tubes in all walls being arranged tangentially. Thus the whole furnace envelope forms part of the main circulation.

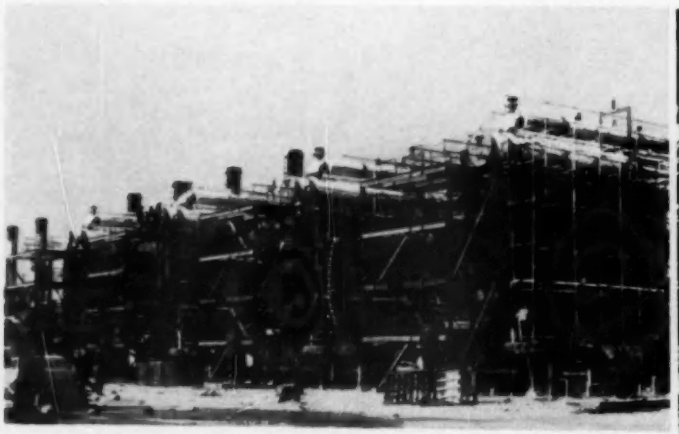
This type of boiler is of a compact design and has a positive natural circulation which is ensured by the arrangement of the heating surface, and the use of Babcock & Wilcox cyclone steam separators. The superheater (1,280 sq. ft.) is of the Babcock & Wilcox inverted " U " type (self draining), the tubes being expanded into boxes 12-in. o.d. The air-heater (8,000 sq. ft.) is of the Babcock cross-flow tubular type arranged for gas flow inside the tubes and 3-pass air-flow on the outside.

Each boiler furnace has four burners which will fire either gas or oil. The burners and the fuel oil pumping equipment were supplied by Peabody Engineering Co. The mechanical draught system is designed as a balanced system and control is by means of dampers. The fans are of the Sirocco type supplied by Davidson & Co. Ltd. The i.d. fan, driven by a 57 h.p. motor, will handle a maximum continuous output of gas at the fan outlet of 44,000 cu. ft./min., while the f.d. fan (driven by a 66 h.p. motor) will handle a maximum continuous output of 24,000 cu. ft. at the inlet.

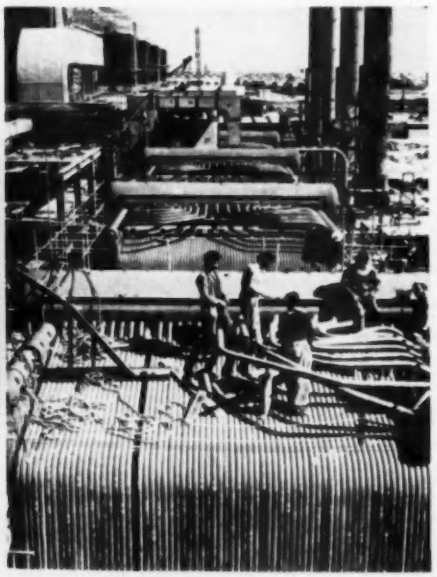
A separate instrument panel supplied by Bailey Meters & Controls Ltd. is provided for each boiler and the following instruments are fitted : Bailey steam meter, feedwater meter, gas flow/air flow recorder, boiler draught gauges, multipoint temperature indicator, remote manual control gear for f.d. and i.d. fans, pressure gauges, Yarway water-level indicator. Feedwater flow is regulated by means of a Copes " Flowmatic " controller.

Feed pumps

The boiler feed pumps (three electrically-driven, and two steam-turbine-driven units) were supplied by G. & J. Weir Ltd., Glasgow. Each pump has an output of 100,000 lb./hr. with a suction temperature of 210 deg. F., suction pressure 12 lb./sq. in., discharge pressure 293 lb./sq. in. (No-load discharge pressure 875 ft.) For the steam turbine driven pumps the steam inlet pressure is 200 lb./sq. in., temperature 720 deg. F., exhaust pressure 10 lb./sq. in., steam consumption per pump is 3,350 lb./hr. The total number of pumps now

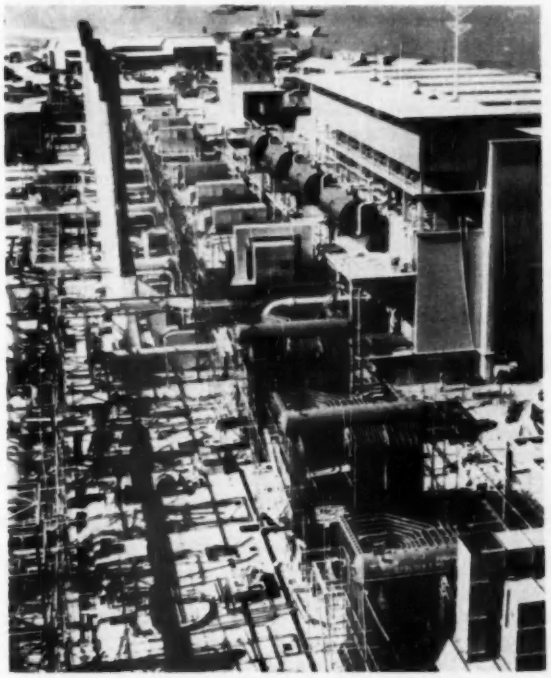


(Above). The four 525,000 gal./day Westinghouse evaporator units for distillation plants C and D approaching final stages of erection.



(Right). The four 80,000 lb./hr. Babcock & Wilcox boilers being erected for distillation plants C and D. The new power station " B " is seen in top l.h. corner.

installed is 13, of which four are steam driven. The steam pumps are normally standby, but automatic cut-in on falling line pressure is provided for both types of pump. The electric cut-in is by pressure switch supplied by Londex Ltd.



(Above). View showing (in foreground) the new 80,000 lb./hr. B. & W. boilers for distillation plants C and D, and beyond (them) the seven original B. & W. boilers of similar capacity for distillation plants A and B, and for power station " A " which is seen in top R.H. corner.

(Right). Circulating-water intake pipes for the new power station " B," showing also pump-house at end of the 600-ft. long jetty.

Pressure reducing and desuperheating

Steam is generated at 210 lb./sq. in. 720 deg. F., and as the steam to the evaporators is to be at 10 lb./sq. in. 250 deg. F. it is necessary to pressure reduce and desuperheat. This is done in two stages :—the first stage is to pressure reduce and desuperheat to the conditions in the L.P. ring main which contains steam at 10 lb./sq. in. and 390 deg. F., which are the conditions of the pass-out steam from power station (A) turbines. A pressure-reducing valve and desuperheating unit is installed in the main steam leg from each boiler to give the following :—

Steam	
Maximum initial flow (lb./hr.)	52,900
Minimum final flow (lb./hr.)	60,300
Initial pressure (lb./sq. in.)	210
Initial temperature (deg. F.)	720
Final temperature (deg. F.)	390
Desuperheating water	
Maximum flow (lb./hr.)	7,400
Pressure (lb./sq. in.)	160
Temperature (deg. F.)	210

The second stage is to desuperheat from L.P. ring main conditions to the conditions required at the evaporators. A desuperheating unit is installed in each leg to each of the four evaporators to give the following :—

Steam	
Normal initial steam flow (lb./hr.)	72,800
Design initial steam flow (lb./hr.)	81,740
Normal final steam flow (lb./hr.)	77,800
Design final steam flow (lb./hr.)	87,360
Steam pressure (lb./sq. in.)	10
Initial steam temperature (deg. F.)	320 to 390
Final steam temperature (deg. F.)	250
Desuperheating water	
Normal flow (lb./hr.)	5,000
Design flow (lb./hr.)	5,620
Pressure (lb./sq. in.)	80/100
Temperature (deg. F.)	210

All operations are actuated by servomotors. Operation is normally automatic but there is provision for manual control from the control panels which are located on the boiler firing-aisle. All the pressure reducing and desuperheating equipment was supplied by James Gordon & Co. Ltd.

Circulating-water system

A pump-house at the end of a 600-ft. long jetty houses the main circulating-water pumps which were supplied by Vickers Armstrongs Ltd., and are of the vertical-spindle axial-flow type, driven by 135 h.p. motors, at a speed of 736 r.p.m. Two pumps, each of 1,000,000 gal./hr. capacity, were installed on the existing jetty to meet the new demand, the circulating water being drawn up through the bellmouth of the pump, protected by rough bar screens, and then conveyed along 30-in. bore C.I. pipes supplied by Stanton Ironworks Ltd. The discharge is taken into a screen chamber and thence through rotary-disc type screens (supplied by Ledward & Beckett Ltd.) to the culverts. A branch culvert leads to the intakes of the evaporator circulating-water pump intakes.

Marine fouling of the cooling-water intakes, and slime fouling of the condensers is eliminated by an automatic, intermittent chlorination plant manufactured by Wallace & Tiernan Ltd. The chlorine gas passes from the containers to a panel mounted pressure reducing valve and is then metered under vacuum by a high capacity master chlorinator allowing for a maximum capacity of 250 lb. of chlorine per hour. The metered gas is absorbed in the water supply employed for plant operation and the resultant balanced solution is conveyed along the

jetty in a bus main to the pump house, a distance of over 800-ft. A manifold distributes the chlorine solution to the areas adjacent to the suction intakes of the circulating-water pumps.

From a panel in the circulating-water pump house, a chlorination programme controller permits a very wide range of selection of both the frequency and duration of chlorination. The plant may be operated according to a programme or else under hand switch control for more prolonged periods of chlorination, if required. From the same panel, the supply of chlorine solution may be cut off from the intake of any circulating-water pump that is not in use. Safety is assured by the vacuum principle of design which prevents the leakage of chlorine gas to the atmosphere. An alarm circuit gives audible and visual warning of a drop in gas or water pressure and automatically shuts down the whole chlorination plant.

Distillation plants "C" and "D" (electrical equipment)

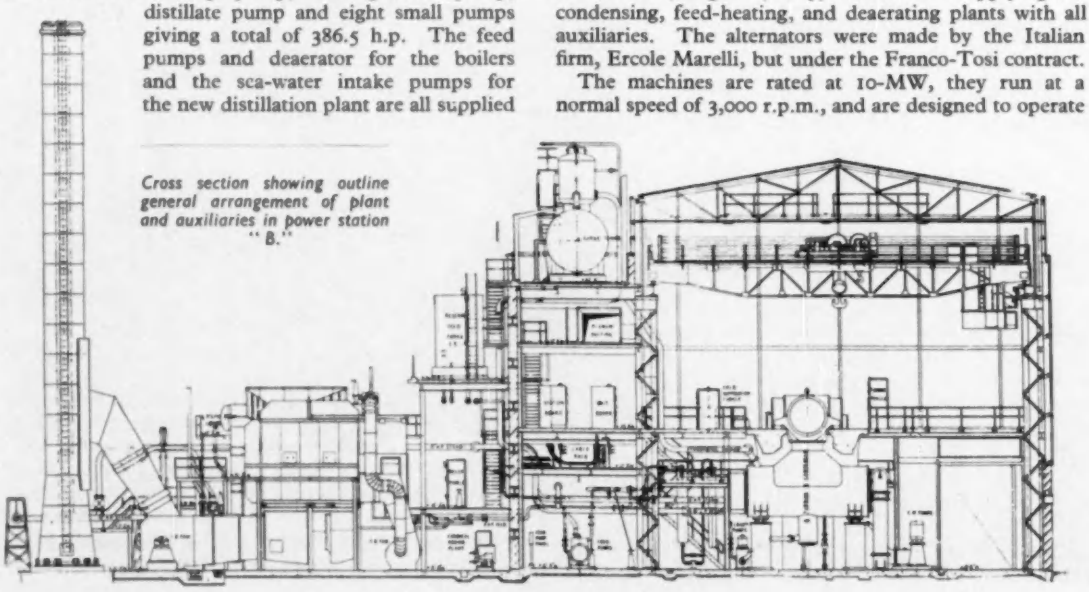
The electricity supply for this plant is obtained from the 11-kV duplicate busbar switchboard with a bus-section and bus-coupler (manufactured by English Electric Co. Ltd.) in power station (A). This switchboard is fed by the four 7.5-MW alternators generating at 11-kV. Separate radial 11-kV feeders are taken from either side of the 11-kV bus-section switch to the two 1,500 kVA 11 kV/433 V transformers which were supplied by Foster Transformers Ltd. Each transformer feeds a main distillation plant contactor board supplied by Electro Mechanical Manufacturing Co. Ltd., Scarborough, either side of a bus section switch. Each half of the board supplies the auxiliaries of two 525,000 gal./day evaporators and two 80,000 lb./hr. boilers, as well as the lighting and power socket outlets required for these items of equipment. An outdoor type contactor board, again supplied by Electro Mechanical Manufacturing Co. Ltd., Scarborough, is provided on each 525,000 gal. evaporator raft for controlling the auxiliaries, i.e. brine recirculating pump, cooling-water pump, distillate pump and eight small pumps giving a total of 386.5 h.p. The feed pumps and deaerator for the boilers and the sea-water intake pumps for the new distillation plant are all supplied electrically from the 415-volt switchboards included in power station (A). The 415-volt cubicle-type main distillation plant board uses d.c. solenoid-closed, air-break switchgear, rated at 25 MVA, and d.c. controlled contactor-type switchgear, protected by fuses rated at 25-MVA. The d.c. supply for both the switchgear and contactor gear is obtained from the 240-volt main tripping and emergency lighting battery supplied for the 33-kV switchgear in power station (B).

New power generating plant (Power Station "B")

As regards the other major project (power station (B)), it was decided that the increasing electrical load demands necessitated the installation of a further 80-MW of generating capacity of which 40-MW would be installed in the first instance. The other plants, to which reference has already been made, have been interconnected, and thus power station (A) served the dual purpose of electricity generation and the passing out of steam to the evaporators. Power station (B) has been installed purely to generate electricity, and the 40-MW output will be supplied from four 10-MW condensing sets, steam to the turbines being supplied by four 125,000 lb./hr. boilers. Located adjacent to and to the east side of power station (A), the new power station is arranged for unit operation although there is interconnection to give different arrangements if necessary or required. The turbine operating floor is at the 23-ft. 6-in. level with the surge tanks and deaerators at the 47-ft. 6-in. level. The reserve feed tanks are 31-ft. 6-in., above the boiler firing-aisle which is at 10-ft. 3-in. Feed pumps are at 6-in. level with the boilers located to the south side of the building, while to the north side are located (at ground level) the main generating set, and the unit and interconnector transformers. Constructional work was started in March, 1956, and the first turbo-alternator unit is being commissioned now. The other three units will be commissioned at intervals of two months.

The four turbo-alternators are being supplied by Franco-Tosi, Legnano, Italy, who are also supplying the condensing, feed-heating, and deaerating plants with all auxiliaries. The alternators were made by the Italian firm, Ercole Marelli, but under the Franco-Tosi contract.

The machines are rated at 10-MW, they run at a normal speed of 3,000 r.p.m., and are designed to operate



Cross section showing outline general arrangement of plant and auxiliaries in power station "B."

with steam at 400 lb./sq. in. and 800 deg. F. The turbines are condensing units which give an absolute exhaust pressure of 3-in. Hg at the turbine exhaust flange at 10-MW when operating with feed heating and circulating-water temperature of 90 deg. F. The alternators generate at 11-kV 3-phase 50 c/s and have a maximum continuous rating of 10-MW at 0.75 p.f., and they feed a 33-kV switchboard via generator transformers ratio 11/34.5 kV. These transformers were supplied by Le Matérial Eléctrique, Lyons, France. The four 7.5-MW turbo-alternators in power station (A) are connected directly to an 11-kV switchboard which in turn is connected to the 33-kV switchboard via two 11/33-kV 10-MVA interconnector transformers with on-load tap-changers. The new alternators are air-cooled, the cooling air being circulated by shaft-mounted fans. The air coolers are of the horizontal tubular water-cooled type, with a cooling surface 10,000 sq. ft.

The Franco-Tosi condensers are of the surface type—capacity 65,000 lb./hr. with a cooling surface area of 9,350 sq. ft. and 9,200 gal./min. of cooling water at 90 deg. F. The Yorcoron tubes for both air-coolers and condensers were supplied by Yorkshire Copper Works Ltd. Two 100 per cent. duty condensate pumps supplied by Drysdale & Co. Ltd. are provided for each condenser, one pump being for standby purposes.

Boilers (Power Station "B")

The four boilers supplied by Babcock & Wilcox Ltd. are also of the F.H. integral furnace type, and designed for a m.c.r. of 125,000 lb./hr. of steam at a pressure of 425 lb./sq. in. and a temperature of 830 deg. F. at the superheater outlet when fired with natural gas. The feedwater inlet temperature is 300 deg. F.

Automatic combustion control equipment supplied by Bailey Meters & Controls Ltd. has been provided for each boiler. It is pneumatically operated—air being supplied from compressors at a pressure of 100 lb./sq. in. The control system is connected only to the gas fuel supply, and initiation is by the master pressure controller connected to the main steam outlet from the boiler.

Fuel firing equipment including pumping plant, oil sprayers and gas burners, also electric gas igniters for lighting up purposes, was supplied by Peabody Burners Ltd.

One F.D. and one I.D. fan are provided for each boiler, the former having two impellers driven from a common centrally-positioned motor. This gives a greatly improved lead-in from the fan to the air-heater and provides good air distribution over the width of the air heater. The fans were supplied by James Howden & Co. Ltd.; the f.d. units are driven by 90 h.p. motors and the I.D. units by 130 h.p. motors.

The air heaters are of the Babcock horizontal tubular type in two sections, giving a total heating surface of 22,160 sq. ft.

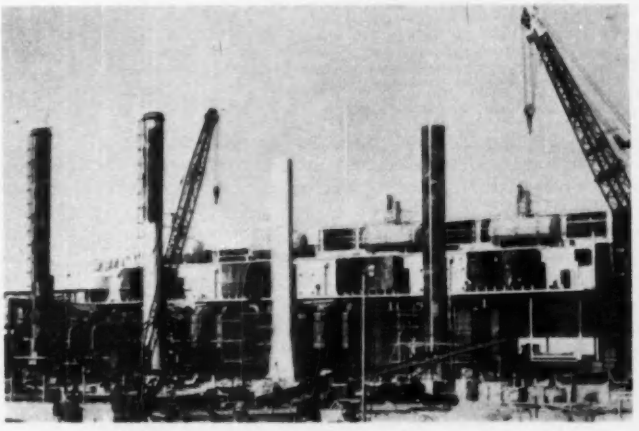
Air by-pass ducts, and hot air recirculation ducts are provided, the latter being used during each lighting up period, during which period the air-heater can be virtually isolated until the gas temperatures reach a suitable figure.

The steel chimneys (supplied by Babcock & Wilcox Ltd.) are like the chimneys serving the distillation plant boilers, 70-ft. high, and have a steel sheath inside them which provides an air gap insulation.

With the installation of these 125,000 lb./hr. boilers, Babcock & Wilcox Ltd. will have provided to the Kuwait installation, a total steam generation capacity of 1,780,000 lb./hr.

Feed pumps (power station "B")

There are two feed pumps for each of the four boilers—one being electrically driven, and the other steam-turbine-driven. The latter is used normally as a standby unit. Each pump is designed to deliver 150,000 lb. of feedwater per hour against a head of 550 lb./sq. in. Water is supplied from the storage tank of a deaerator located approx. 50-ft. above the pump suction, the water leaving the tank at a maximum pressure of 5 lb./sq. in. and temperature 227 deg. F. or a minimum of 7 lb./sq. in. absolute and temperature 177 deg. F. A high-pressure heater which raises the feedwater temperature to 300 deg. F. is installed between the feed pump and the feed header. The pumps have a falling pressure volume characteristic to ensure satisfactory operation in parallel with one another. Steam for the turbine-driven pumps is supplied at a pressure of 400 lb./sq. in. and a temperature of 800 deg. F. Both types of pump have been provided with automatic cut-in gear to operate when on standby or when the line pressure is falling. As in the case of the distillation plants, the feed pumps were supplied by G. & J. Weir Ltd., Glasgow.



General view showing power station "B" approaching final stages of construction.

Circulating-water system

As with the other plants, the circulating-water system is based on a jetty and culverts. The steel piled jetty, designed to carry eight cast-iron pipe lines, is 700-ft. long with a pump house at the end. Six of the pipe lines are necessary for the present installation and the other two will be required for future extension. The six lines installed were provided by the Staveley Iron & Chemical Co. The circulating-water pipelines are of two sizes—30-in. and 24-in. diam. respectively, and are connected to the pumps which have also been designed in two sizes in order to give flexibility.

The jetty pumps are of 1,000,000 and 500,000 gal./hr. capacity respectively. Initially, there have been installed four of the former capacity and two of the latter. The design of the pumphouse allows for future installation of two 1,000,000 gal./hr. pumps to cater for the extension. All six pumps were supplied by Vickers Armstrongs Limited, and are of the Vickers Gill vertical-spindle axial-flow type. The 1,000,000 gal./hr. pumps are electrically driven by 150 h.p. motors at 720 r.p.m. and the 500,000 gal./hr. units by motors of 75 h.p. at 960 r.p.m.

The pipelines discharge into a screen chamber and thence through six Ledward & Beckett screens into the inlet culvert. The screens each have a capacity of 1½ million gal./hr. Circulating water is pumped from the culvert and passed through the turbine condensers, each of which is provided with two Vickers Gill vertical axial-flow pumps which normally operate in parallel. Each pump has a capacity of 338,000 gal./hr. and is driven by a 50 h.p. motor. Chlorination equipment supplied by Wallace & Tiernan Ltd. is virtually the same as that for power station (A).

Plenum plant

The plenum plant provided for preventing ingress of sand and dust into the turbine house and to provide some degree of cooling, is housed in the switch-house building which is located adjacent and to the west of the turbine house. The air ducting is led through to the turbine house at the 47 ft. 6 in. level. The plant is designed to provide 78,000 cu. ft./min. of filtered air to the present building. Provision has been made to supply the total air required when the power station extension is built—120,000 cu. ft./min. will then be required. The following shows the air changes for which the equipment is designed.

Turbine house (below operating floor)	7 changes/hr.
Turbine house (above operating floor)—North	6 changes/hr.
Turbine house (above operating floor)—South	3½ changes/hr.
Switch house and battery rooms	3 changes/hr.

These air changes give overall air changes of five per hour.

The air filter as installed will handle the final duty of 120,000 c.f.m. The plenum fan will also handle the final duty but a higher duty motor will need to be installed. Air inlet louvres are set in the wall of the plenum plant room to deflect and collect the heavier particles of dust. Air is then drawn through a filter which is of the automatic self-cleaning viscous type. The filter is an endless curtain which passes through an oil-bath at the bottom. An automatic timer actuates a motor at 12-minute invertals for eight seconds, equivalent to 1-in. of curtain travel. The plenum equipment was supplied by Air Control Installations Ltd.

Pipework

The pipework for both the steam and water services was made by Stewarts & Lloyds Ltd., the fabrication and erection being carried out by Aiton & Co. Ltd.

Heat insulation

The insulation material used was 100 per cent. asbestos sectional type, of appropriate thickness and designed to insulate most surfaces operating at temperatures in excess of 135 deg. F. For pipework inside the building, the insulation is finished off with a layer of hard-setting composition ½-in. thick, then covered with close weave calico and finished with a wash solution of asbestos to give a smooth hard surface. For pipework outside the building, the insulation is finished off with 22 S.W.G. galvanised sheet steel secured by self-tapping screws and 18 S.W.G. 1-in. wide steel bands. All material was supplied and applied by Halsen Asbestos Ltd., London. This specification also applied to the distillation plant where the material was supplied and applied by The Cape Asbestos Co. Ltd.

Electrical equipment (power station "B")

Electricity is generated by four 10-MW turbo-alternators at 11,000 V, 50 c/s, 3 phase. The alternator terminals are connected by means of cables direct to 12.5-MVA generator transformers fixed ratio 11/33 kV, which in turn are connected by means of cables to the main duplicate busbar 33-kV switchboard. A duplicate supply is also given to this switchboard through two 10-MVA, 11/33 kV interconnector transformers with on-load tap changers from power station "A" in which four 7.5-MW steam turbo-alternators are installed. Both transformers operate in parallel with the generator transformers. The 33-kV system is earthed through a generator or interconnector transformer neutral circuit breaker and an earth resistor. The duplicate busbar 33-kV switchboard is in two sections, with a bus section and bus coupler switch, and distributes electricity via overhead lines and oil-filled cables to the major sub-stations in Kuwait. The switchgear is of the indoor vertical-isolation, horizontal-drawout, solenoid operated, metalclad type.

Control room

The control room serving the present power station "A" was designed to also accommodate the equipment necessary for power station "B." In addition to the equipment for power station "A," the control room accommodates the 415 V auxiliary switchgear controls in the form of a miniature mosaic type of control board operated by direct wire control at 50 V d.c. Conventional cubicle type control, relay and metering boards are used for the 33-kV feeder and transformer circuits, whilst desk-type cubicles accommodate the machine controls.

The station d.c. supplies are obtained from a 240 V lead-acid battery maintained by duplicate battery chargers of the mercury-arc type.

Station auxiliary supplies

Two 1,500 kVA 11/.415 kW interconnector transformers feed a common "station" board either side of a bus section switch. The 11-kV feed for these transformers is obtained from power station "A" and this switchboard is used to give starting-up supplies to each turbo-alternator and boiler unit and normal supplies for sea-water pumps, cranes, lighting and all services common to all units. Each turbo-alternator and boiler unit has a "Unit" switchboard consisting of air circuit breakers and contactors for supplying and controlling the various auxiliaries, viz. feed pumps, extraction pumps, circulating-water pumps, lubricating-oil pumps, i.d. and f.d. fans and barring motor. During the starting-up of the units, the supply to the "unit" board is obtained from the "station" board, but once they are operating, the supply to the "unit" board, is obtained from "unit" transformers of 750 kVA, 11/.415 kV, which are connected

by means of cables direct to the alternator terminals. The main 415-V air circuit breakers on the " unit " and " station " boards are normally controlled from the direct wire mosaic diagram in the control room but provision is made for local control during maintenance.

Gas line

As has been stated, the normal boiler fuel used is natural gas. So far a sufficient supply of gas has been available, and is delivered through an 8-in. steel line, which runs between the oilfield and the industrial site at Shuwaikh. With the decision to instal further plants, and thereby increase considerably the fuel consumption, it became necessary to provide a new gas line, which is required not only to cater for the industrial plants at Shuwaikh, but also a large demand in Kuwait for gas for domestic purposes.

The anticipated demand is 49,000,000 cu. ft./day of gas, and it was decided to instal a 16-in. pipe line. In the first instance the line was to run from Shuwaikh to Magwa gas gathering centre, a distance of nearly twenty miles. This length of 16-in. o.d. × 0.312 in. thick hot-finished seamless steel piping to A.P.I. specification was supplied by Stewarts & Lloyds Ltd. The Contracting & Trading Co. of Beirut were appointed to lay the line, and work started on January 1st, 1958, to be completed in 14 weeks.

After the initial arrangements had been made for the gas line, it was decided that in order to obviate any possibility of failure in supply from Magwa it was necessary to extend the line a further 90,000-ft. to connect in to gas-gathering centres at Burgan. The extra supply of 16-in. diam. piping was also ordered from Stewarts & Lloyds Ltd.

The gas scrubbers and associated equipment necessary for this installation were supplied by Ruston & Hornsby Ltd., and Prat-Daniel Ltd.

Architectural considerations

The architectural problem involved in the construction of the power station building was one of providing a shelter from direct sun rays and inclement weather for the mechanical and electrical plant installed therein, and creating a volume that will not attain a temperature greater than the ambient. For building in Kuwait where shade temperatures vary from 30 deg. F. to 120 deg. F., previous scientific opinion has favoured walls of high thermal content and mass (in order to absorb night temperatures, and to act as a cold " radiator " during daytime). Subsequent experiments, however, have shown that light cladding, combined with insulation and carefully considered cross ventilation at high level, can in fact be equally effective. This, together with the improvement in availability of materials and shipping facilities, determined the treatment at Kuwait.

The load bearing structure is of steel frame construction with vertical cladding in either non-load bearing brickwork faced with sand-lime bricks of local manufacture, or in modular aluminium sheeting backed with 1-in. Rocksil, faced internally with asbestolux sheets; this latter cladding is also applied to the roofing. Window frames are of aluminium glazed with non-actinic glass and protected with aluminium sunbreakers. Expansion joints are provided at suitable intervals to cater for the movement caused by the extremes of temperature, in concrete slabs and brickwork but because of the profile of the aluminium cladding, which allows expansion and contraction in each sheet, the expansion joints do not pass through the cladding.

The external design of the building therefore relies on the use of these economic elements together with clean detailing, the solid walls of the transformer bays and the transformers themselves painted in strong primary colour acting as strong free standing forms in contrast to the sheet aluminium envelope behind them—this in turn picking up many variations in colour from the intense reflected light. Internally, the design incorporates cool colour on the acoustic ceiling, wall lining and exposed steelwork, and an illusion of coolness is increased by the bluish light coming through the non-actinic glass. This provides a background to the plant forms and pipework which are to be in clear primary colours. The architectural design was the responsibility of Messrs. Farmer & Dark F./F.R.I.B.A., London, while the civil engineering works were executed by the Austrian Kuwaiti Engineering Company (Eduard Ast & Cie.).

Acknowledgments

Our acknowledgments are due to Messrs. Ewbank & Partners Ltd. for supplying much of the data contained in this description, and to His Excellency Sheikh Jabir al Ali al Subah, President of the Department of Electricity, Kuwait, and Mr. J. D. Addison, M.B.E., M.I.Mech.E., M.I.E.E., Chief Electrical & Mechanical Engineer, Government of Kuwait, for permission to publish the article.

KEMPE'S ENGINEER'S YEARBOOK

The two volumes of " Kempe's Engineer's Yearbook " for 1958 (the 63rd edition) are now available, price 82s. 6d., plus postage 2s. 6d., from the publishers, Morgan Brothers (Publishers) Ltd., 28, Essex Street, Strand, London, W.C.2. Once again the subject matter has been revised and enlarged, valuable additions being made to the following chapters :— " Welding and Cutting " (rewritten to cover argon arc welding, self-adjusting arc welding, controlled arc welding, gas shielded arc cutting, spark machining, oxygen cutting, hard-facing) ; " Water Engineering " (details of rainfall and catchments, water treatment and plant, reservoirs, dams, water schemes including pumped storage) ; " Iron and Steel " (revised text on corrosion and protective coatings) ; " Non-ferrous Metals and Alloys " (revised with additional text and tables) ; " Foundry Practice " (revision of diecasting) ; " Grinding Abrasives, etc." (details of blasting processes, new abrasive materials) ; " Machine Tools " (new tables of machine details and text includes cartridge-operated hammers and ceramic tool tips) ; " Wire Ropes " (new text and tables); " Harbours and Docks " (revised text on tides and movement of water, also details of uniform system of buoyage) ; " Railway Engineering "—permanent way (details of railfastening devices) ; " Aero-dynamics " and " Aircraft Propulsion " (these two chapters contain revised text dealing with measurement of air speed, wind tunnels, supersonic flight, fuels including high energy fuels, compounded power units, helicopters, parachutes) ; " Electronic Engineering " (additions to text deal with oscilloscopes, valves and transformers, including new illustrations) ; " Atomic Power " (additional text and illustrations) ; " Heating, Ventilation and Air Conditioning " (revised text and new illustrations of charts for pipe sizes, and flow of air in ducts) ; " Public Health Engineering " (the section dealing with public cleansing has been fully revised) ; " Concrete and Reinforced Concrete " (revised in accordance with new specifications). There are altogether more than eighty chapters, each dealing thoroughly with a separate subject, and each edited by an authority in the particular field. A comprehensive index contains over 17,000 references.

A Large Coal-Handling Plant with Extensive Application of Fluidrive

IN the April, 1957, issue of this journal we published an illustrated description of Castle Donington power station of the Central Electricity Generating Board. This is the first station to commission single boiler/turbo-alternator units of 100-MW rating. The six Babcock & Wilcox boiler units each have an m.c.r. of 830,000 lb./hr., the steam pressure at the superheater outlet being 1,600 lb./sq. in. and the temperature 1,060 deg. F. Owing to space limitations, we were not able to include more than a brief reference to the extensive coal-handling plant, which is one of the largest in the country, with a total handling capacity of 960 tons/hr. to the boiler bunkers. The complete handling plant was designed and installed by Babcock & Wilcox Ltd.

A coal-handling plant of such magnitude obviously entails an extensive variety of drives. At Castle Donington, Fluidrive, which for some years has been widely standardised in coal-handling plants for such duties as wagon haulers and tipplers, dragline scraper winches, belt-conveyors, gravity-bucket conveyors and crushers, has been used on a very wide scale. The fluid couplings throughout the system were made and supplied by Fluidrive Engineering Company Limited.

Rail-borne coal arrives at the tippler house where there are four Babcock & Wilcox side-discharging wagon tipplers, fitted with Avery automatic weighers. The tipplers are capable of handling wagons of up to 35 tons gross weight, at a rate of 15 wagons per hour. Each wagon tippler drive unit comprises a Lancashire Dynamo and Crypto "Fankuld" squirrel-cage motor rated at 35 h.p. at 975 r.p.m., with direct-on starter, and size 17.75 fluid coupling. Limit switches for either end of the travel control the motor and solenoid brake, but, apart from the light load start, the fluid coupling provides overload protection in the event of the limit switches getting out of adjustment.

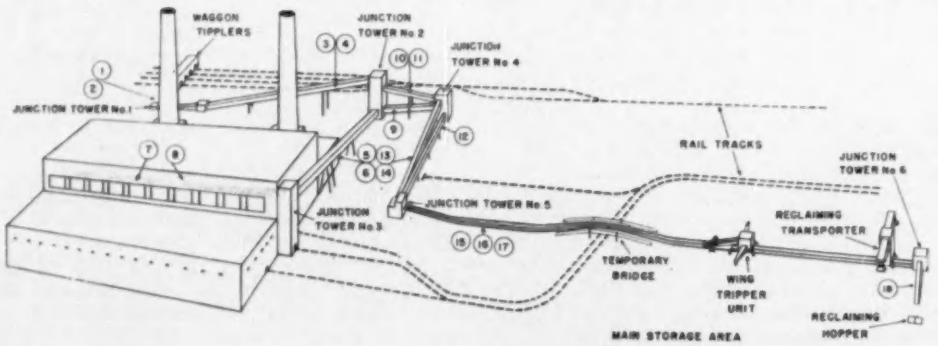
From the tippler hoppers the coal passes, via "Sherwen" electric vibrating feeders and bifurcated chutes, to two 42-in. belt conveyors (Nos. 1 and 2) running at a speed of 400 ft./min. and having a centre distance of 206-ft., which transport it underneath the rail tracks and deliver it over-end at No. 1 junction tower to two 42-in. conveyors (Nos. 3 and 4), running at right-angles to the previous direction. These conveyors utilise the Babcock-Taylor twin-motor tandem drive specially developed for long conveyors. The coal is carried some 460-ft. and delivered to a junction tower No. 2; the conveyor rise being 120-ft. The drive units for conveyors 1 and 2 each comprise a 35 h.p. 980 r.p.m. Lancashire Dynamo and Crypto "Fankuld" squirrel-cage motor, a size 17.75 fluid coupling, and a Wiseman worm gear reducer.

Each drive head for conveyors 3 and 4 has Lancashire Dynamo S.C. Corcooled motors running at 975 r.p.m., and fluid couplings :— the larger being rated at 85 h.p. with a size 23 fluid coupling, and the smaller at 25 h.p. (L.D.C. "Fankuld" motor) with a size 16.25 fluid coupling. It appears that Fluidrive's experience over the years with tandem drives on conveyor systems of exceptional length has proved highly satisfactory.

Junction tower No. 2 contains, with other equipment, the screening and crushing plant, and also the sampling equipment, and forms the key point of the conveyor system. From here, coal may be despatched direct to the bunkers or diverted to the coal storage area which has a capacity of 600,000 tons. The bunkers may be fed either direct from the wagon tipplers, or from storage, or from both simultaneously.

The coal from the tipplers passes through "Tyrock" screens and, if oversize, through crushers to the transfer hopper. From this hopper the coal may leave by two conveyors (Nos. 5 and 6) en route to the boiler house bunkers, or it may be diverted to the storage area by another conveyor (No. 9). Reclaimed coal from the store is delivered by two further conveyors (10 and 11), entering near the top of the tower, and discharging to the common transfer hopper.

Conveyors 5 and 6, which take the coal from the transfer hopper, are each fitted with a separated tandem drive, and transport the coal to No. 3 junction tower which forms an extension to the boiler house bunker bay, a



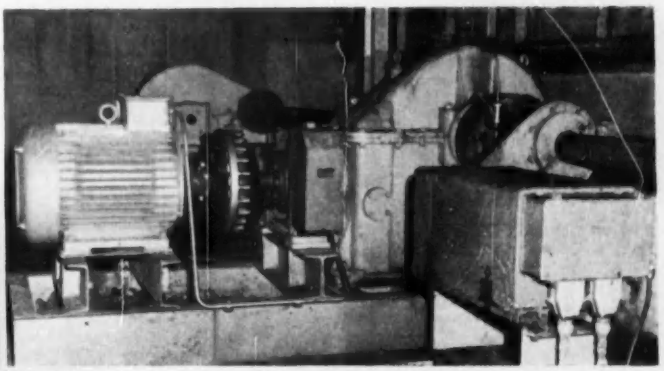
Diagrammatic arrangement of the 960 tons/hr. coal-handling plant installed by Babcock & Wilcox Ltd., at Castle Donington power station.

distance of about 420-ft., and deliver over-end at a height of approximately 125-ft. above ground-level on to conveyors 7 and 8, which run over the bunkers for the entire length of the boiler house. These conveyors are approximately 514-ft. between centres, and are fitted with automatic travelling trippers arranged for discharging coal at the rate of 480 tons/hr. into any of the six bunker pockets. The drive units for conveyors 7 and 8 comprises L.D.C. 55 h.p. 975 r.p.m. "Corcooled" S.C. motors and size 20 fluid couplings.

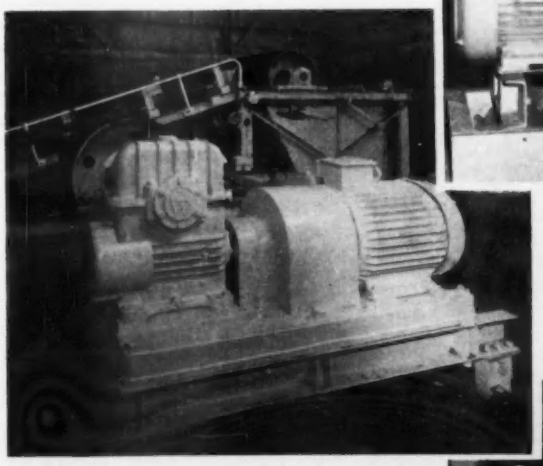
Storage

From No. 2 junction tower to the remote end of the coal storage area, there are three conveyors—one for stocking-out and two for reclaiming. The stocking-out conveyor (No. 9) and the two reclaiming conveyors (Nos. 10 and 11) run from No. 2 to No. 4 tower (about 155-ft.) where the direction changes through a right-angle, No. 9 conveyor delivering to No. 12 conveyor, and Nos. 10 and 11 being fed from Nos. 13 and 14. A further right-angle bend occurs at junction tower No. 5 a distance of 365-ft. away, where No. 12 connects with No. 16 stocking-out conveyor and Nos. 13 and 14 connect with Nos. 15 and 17 reclaiming conveyors. Conveyors 15, 16, 17, are the longest on the system, the run between junction towers 5 and 6 being some 2,076-ft. between centres—the conveyor speed being 550-ft./min.

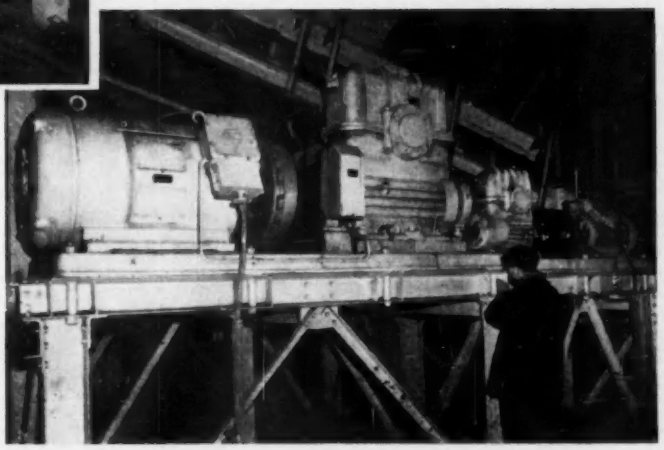
Particular interest is attached to the drives of these conveyors. On account of their unusual length, special consideration had to be given to both temporary and permanent adjustment of belt slack, and to the maximum permissible belt stress when starting up. The patented arrangement evolved utilises a main drive comprising a Lancashire Dynamo 130 h.p., 975 r.p.m. Corcooled motor and size 23 fluid coupling at the delivery end of each conveyor, pulling on the loaded belt, and an L.D.C., 60 h.p., 975 r.p.m. auxiliary drive motor with size 20 fluid coupling at the other end, which pulls on the return side of the belt. By this means, the temporary slack in front of the main drive is taken up by the auxiliary drive at the earliest possible moment, and the maximum belt tension at starting is very considerably reduced. In order to compensate for the temporary stretch of these long belts, gravity type take-up pulleys are arranged at either end of the belt. Any permanent stretch which may occur after running in, and during the normal life of the belt, is dealt with by screw-type "take-ups," which are also provided at each end.



(Above). The drive for each of the Babcock & Wilcox wagon-tipplers comprises a Lancashire Dynamo & Crypto 35 h.p., 960 r.p.m. squirrel-cage motor and a size 17.75 fluid coupling. Each tippler can handle 15 wagons per hour.



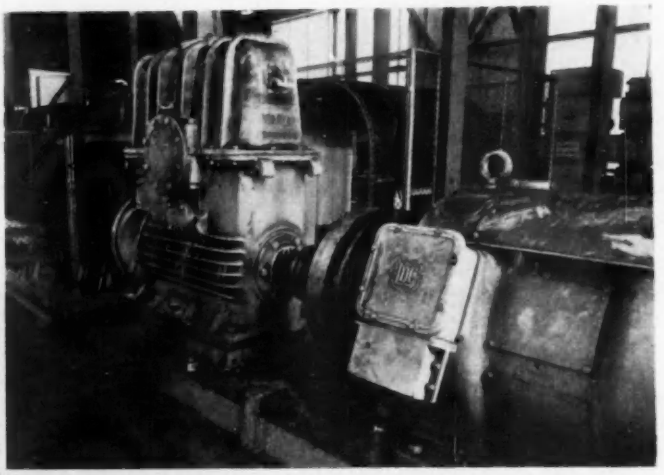
(Above). Drive head arrangement of No. 1 conveyor, with that of No. 2 conveyor in background. Each drive comprises an L.D.C. 35 h.p., 980 r.p.m. motor and size 17.75 fluid coupling.



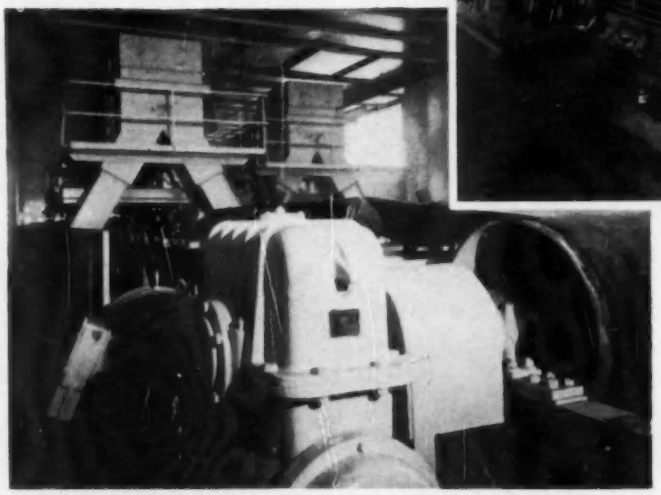
(Right). For conveyors 3 and 4 there are Babcock/Taylor twin-motor tandem drives, the larger comprising an L.D.C. 85 h.p. motor with a size 23 fluid coupling, and the smaller an L.D.C. 25 h.p. motor and size 16.25 fluid coupling.

Stocking-out from conveyor No. 16 is by means of a special tripper, which travels along the conveyor on rail tracks, and distributes the coal by wing conveyors with spans of 44-ft. either side of the main conveyor. Each wing conveyor has a drive unit with a Lancashire Dynamo S.C. motor rated at 18 h.p. at 1,460 r.p.m., and a size 11.5 fluid coupling.

For reclaiming purposes there is a 14-ton electric travelling/grabbing transporter which has a total span of 110-ft. and travels on the same tracks as the wing tripper and is fitted with a grab of 6½ tons capacity, delivering via a hopper with split chutes and vibrating feeders to conveyors 15 and 17. Another method of reclaiming is by means of bull-dozing the coal into a ground hopper which is located some 170-ft. away from the end of the main conveyors, and feeds these by a single conveyor (No. 18) which connects with conveyors 15 and 17 at junction tower No. 6.



(Above). The tail-end drive unit for No. 16 conveyor which is 2,076 ft. long and runs at 550 ft./min. The L.D.C. motor is rated at 60 h.p. and the fluid coupling is size 20.



(Above). Automatic travelling trippers and head drive of No. 7 conveyor comprising L.D.C. 55 h.p. motor with size 20 traction type fluid coupling.

(Below). The Babcock & Wilcox wing tripper has a drive unit with L.D.C. motor rated at 18 h.p., and size 11.5 fluid coupling. In the background can be seen the reclaiming transporter feeding conveyors 15 and 17.

The entire conveyor system is fitted with Babcock cartridge type oil-fitted ball-baring troughing and return idlers, which eliminate the greasing operations associated with many other types of idlers. These greasing operations present no small problem on a handling system of this size, which has a total length of well over four miles of belting. The total horse-power of motors associated with the conveyor drives, and which are all of Lancashire Dynamo & Crypto manufacture, is something over 1,600 h.p., all of which are fitted with fluid couplings.

The main reason why Fluidrive is used on these large coal-handling systems can be briefly summarised as follows :— (a) The squirrel-cage motor is given a light load start and is able to accelerate up to practically full speed from rest, thus developing maximum torque. This is highly advantageous when heavy inertias are involved, as, for example, with wagon tipplers, crushers or heavily-laden belt conveyors. (b) The acceleration of the belt or driven machine is extremely smooth. In the case of the former, the initial tension can be reduced and tail end surging is greatly lessened. (c) The torque transmitting capacity of the fluid coupling can be readily adjusted between 15 per cent. and 25 per cent. of the full load torque of the motor by varying the quantity of oil and provides good overload protection in the event of a stalling condition as can occur with wagon tipplers.

POWER PLANT ENGINEERING during 1957

GENERAL ELECTRIC CO. LTD.

PLANT manufactured by G.E.C. Ltd. commissioned during 1957 included three 60-MW turbo-alternator sets and two 30-MW sets for the Central Electricity Authority, two 30-MW sets for the Kelvin station of the Johannesburg City Council and many of a smaller rating at home and abroad. These bring the total rating of G.E.C. sets placed in service during the last three years to over 1,300-MW. At the Hams Hall " C " station, where the first turbo-alternator was installed in 1956, five 60-MW machines are now in service. Overseas, a contract has been placed for two 60-MW sets for the new Kelvin " B " station, which will make a total of 18 sets exceeding 30-MW rating ordered from the company by the Johannesburg City Council. A further 120-MW reheat machine has been ordered by the Central Electricity Generating Board for the Northfleet station.

In connection with the Ravenscraig iron and steel works project of Colvilles Limited, the company undertook a comprehensive contract covering the complete power station, including civil engineering work. Four gas-fired boilers, three turbo-alternators and two turbo-blowers were completed on the scheduled programme and commissioned early in 1957, just over two years after starting work on an undeveloped site.

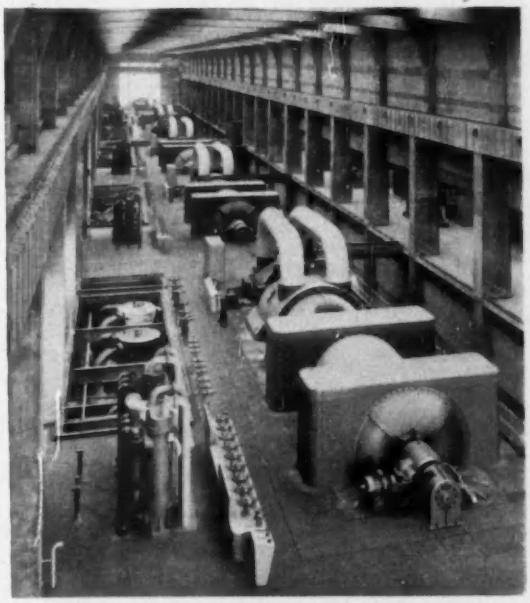
Certain work undertaken in connection with the development of very large reheat turbines is applicable to sets of smaller rating. One example is an emergency valve with on-load test facility which is particularly suited to onerous high-temperature conditions ; apart from its normal function of emergency closure, it incorporates a feature to prevent opening should the governing valves not be operating correctly. To meet the exacting demands on the governor valve-closing mechanism and all interconnected relays made by the acceleration of large reheat turbines when full load is rejected, an acceleration-sensitive device has been incorporated in the speed governor which will cause all steam valves to be completely closed within 0.25 sec.

An automatic voltage regulator of the magnetic amplifier type, which dispenses with the need for a pilot exciter, has also been developed for use with large turbo-alternators where a high degree of accuracy and/or high speed of response are required. The first of this type, for one of the 60-MW turbo-alternators to be installed at Poole power station, has been completed, and further orders are in hand. A further development, associated with turbo-alternators having outputs of 200-MW and above, is the water-cooling of stator windings. While not conferring such a marked advantage as direct hydrogen cooling of the rotor, this method does enable the weight of a wound rotor for units in excess of 200-MW to be kept within the maximum permissible transport weight of about 160-ton.

These notes refer to the activities of some manufacturers of power generating plant and associated equipment, and are continued from p. 49 of the February, 1958, issue of this journal.

Nuclear power

Work on plant for the 360-MW nuclear power station at Hunterston, on the Ayrshire coast, being constructed by the company in association with Simon-Carves Ltd., for the South of Scotland Electricity Board, is now in hand. In parallel with the development of the present type of nuclear power station, work is now being carried out on a new project, the high-temperature gas-cooled reactor. The company has been awarded a contract by the United Kingdom Atomic Energy Authority for a large part of the design and construction of a zero-energy assembly for this reactor, which will be used primarily for the investigation of the nuclear properties of the design without the complications of high heat output and radiation intensity. The high-temperature gas-cooled reactor is a thermal breeder type, operating on the uranium-233/thorium cycle ; that is, fission is primarily due to slow neutrons and more atoms of fissile uranium-233 are produced than are consumed. The basic fuel is thorium. In the laboratories at Erith, now enlarged by taking over further premises, a large number of experiments has been conducted on all aspects of power-station design, not only for those parts of the Hunterston Station that were not already finalised, but

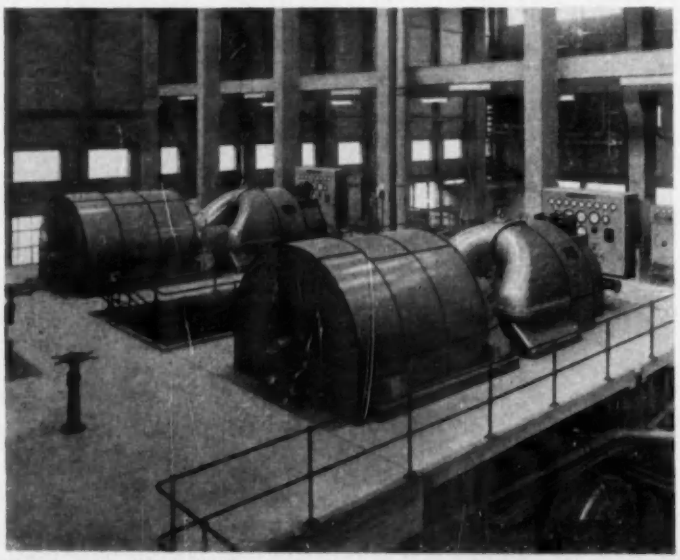


The five G.E.C. 60-MW turbo-alternator sets installed at the Hams Hall " C " power station of the C.E.G.B.

also for future developments. This work has included the design and extensive testing of equipment for installation in a reactor to detect possible bursts in fuel element cans.

Over-voltage protection

Considerable improvements have been made in the past few years in the operating performance of over-voltage protective devices such as surge diverters. More onerous testing conditions are required as a result of these developments, and a new high-voltage laboratory at Witton has been specifically designed to undertake operating duty and also high energy current tests on the latest high-voltage surge diverters. For the operating duty tests, the impulse current equipment is situated close to the high power testing laboratory, which provides the low impedance source of power frequency. It is now possible to test surge diverter spark gaps interrupting power frequency follow currents measured in hundreds of amperes with negligible applied voltage regulation.



(Above). Two G.E.C. 90,000 cu. ft./min. blast-furnace turbo-blowers in the power house at the new Ravenscraig iron and steel works of Colvilles Ltd.

(Right). A G.E.C. one-third scale model of a gas-circulator for the coolant gas of a nuclear power station.

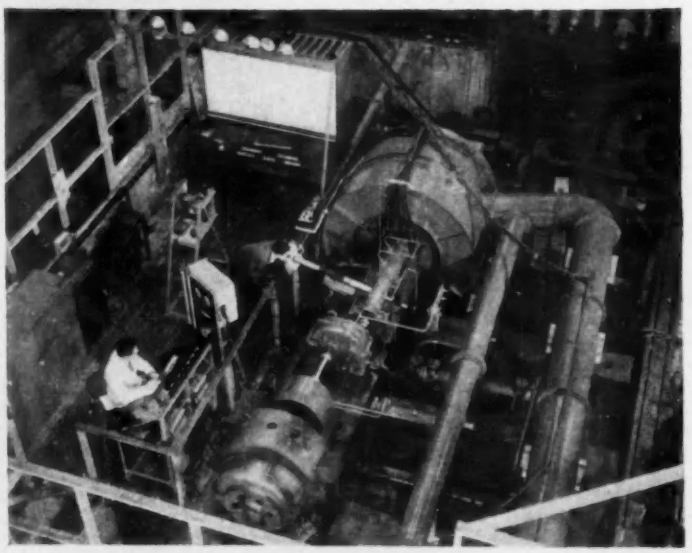
Transformers

During the year, large transformers totalling over 770-MVA have been completed, over three-quarters of this total being for the Central Electricity Generating Board including four 72-MVA generator-transformers for Hams Hall "C" power station, two 60-MVA and three 45-MVA transformers for outdoor substations at Bridgwater, Alton and Chesterfield. Of the overseas orders completed, the 22.5/30-MVA, 132/72-kV 60-cycle auto-transformer for the Saskatchewan Power Corporation, Canada, is of particular interest. Grain-oriented steel is used for the core and a tap-changing switch on the high voltage winding covers a voltage range of + 5 to — 20 per cent. in 21 steps. Cooling fans, which are automatically controlled by switches in the temperature indicating apparatus, are mounted underneath the cooling radiators to provide the additional cooling required for the higher rating of 30-MVA. A second transformer of similar design but rated at 30/40-MVA is now being built for the Canadian company.

Steelworks and materials handling

For the Indian Government's new steelworks at Durgapur, near Calcutta, the Materials Handling Department of the Fraser & Chalmers Engineering Works has received orders comprising the complete ore handling and blending plant, which is designed for dealing with limestone, dolomite, and miscellaneous materials. The plant includes three wagon-tipplers, each of 40 tons gross capacity, for discharging the ore and limestone to the conveyor system, which is some four miles in length. Very large contracts in hand at Witton for the Durgapur project include electrical equipment for a 16-strand Merchant mill driven by individual d.c. motors from 150 to 800 h.p., amounting in total to 8,000 h.p., and supplied through grid-controlled mercury arc rectifiers.

The installation of three electrolytic tinning lines at the Velindre works of the Steel Company of Wales Ltd. represents a very substantial increase in the tinplate manufacturing capacity of this country. All the electrical driving equipment for these lines, the first of their type to be made in Great Britain, was supplied by the G.E.C. Electrical equipment is now being



manufactured at Witton for the main drive of an electrolytic pickling line for the Abbey Works of The Steel Company of Wales similar to the one already in successful operation at the Trostre Works of the same company, which was installed in 1952. The company has also been made responsible for the complete re-electrification of the 6-stand hot-finishing mill at the Ebbw Vale works of Richard Thomas and Baldwins Ltd.

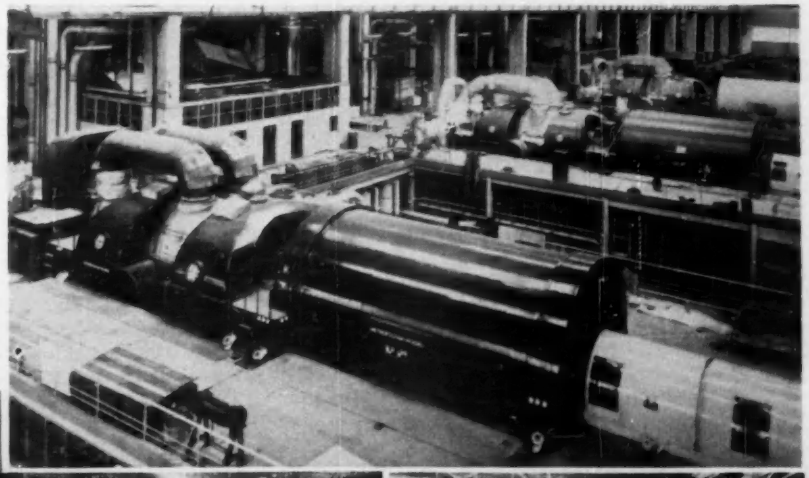
METROPOLITAN-VICKERS ELECTRICAL CO. LTD.

A NUMBER of turbo-alternator sets manufactured by Metropolitan-Vickers and installed throughout the world were commissioned during the year. Apart from these activities and others reported from the many fields in which the company has interests, it should be recorded here that, as stated in the March, 1958, issue of this journal, Metropolitan-Vickers collaborated in the design and were the main contractors for the construction of ZETA—the apparatus with which the U.K.A.E.A. achieved the world's first controlled thermonuclear reaction.

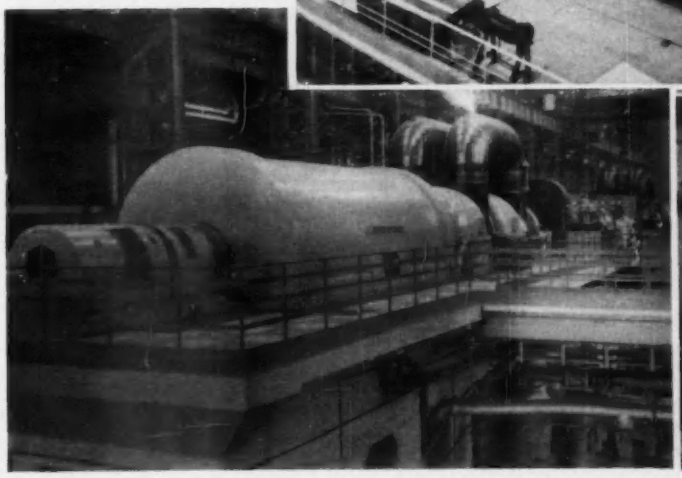
During the period under review 31 Metropolitan-Vickers steam turbo-alternators were commissioned, with a total generating capacity of 1,013-MW. In Great Britain, nine machines were commissioned in C.E.G.B. power stations, including the second, third and fourth 100-MW sets installed at Castle Donington. Machines of 60-MW capacity were put on load at Portishead "B," North Wilford, Chadderton, and South Denes power stations. In addition to these close-coupled, two-cylinder machines, a three-cylinder 52.5-MW set was installed at Deptford East. With the exception of Deptford East and South Denes, all the stations mentioned have condensing plant and feed-heating equipment supplied by the company. It is interesting to note that among C.E.G.B. power stations, Castle Donington recorded the highest overall thermal efficiency for the year ending March 31st, 1957, with Littlebrook "B" and Portishead "B" stations—each with 60-MW units —occupying third and fourth positions. Littlebrook "B," which has two M-V reheat machines, again enhanced its reputation for efficient operation, and Portishead "B," which has two-cylinder close-coupled turbines of the latest design, was the most efficient of the 900 lb./sq. in., 900 deg. F. stations ; the only such station to record an annual average efficiency higher than 30 per cent.

In Canada, two 33-MW 3,600 r.p.m. hydrogen-cooled turbine-alternator sets were put into service at Brandon (Manitoba Hydro-Electric Board), and at Estevan (Saskatchewan Power Corporation). In Rhodesia, the first of two 30-MW, 3,000 r.p.m. two-cylinder machines was commissioned at Salisbury No. 3 station, and the fifth 20-MW set went into service at Umniati. Other

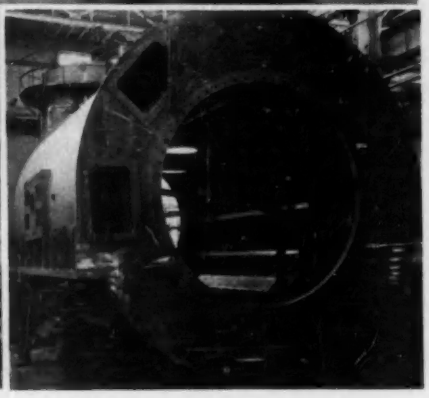
(Right). Three of the four Metropolitan-Vickers 100-MW turbo-alternators installed at the Castle Donington power station.



(Below). Two of the three Metropolitan-Vickers 60-MW turbo-alternators supplied to the Chadderton "B" power station.



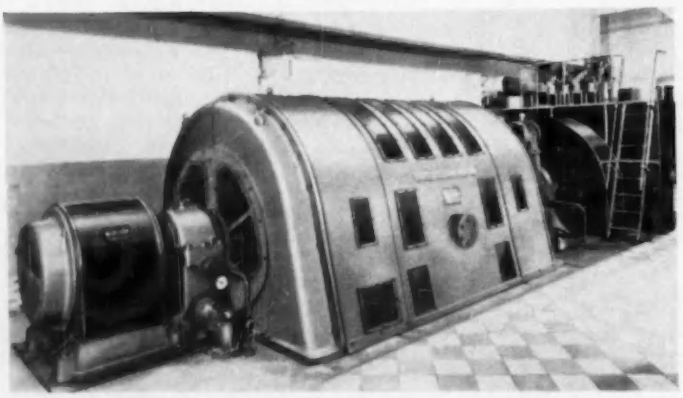
(Below, right). The fitting of the core-bars in the stator of a Metropolitan-Vickers 120-MW turbo-alternator for Agecroft power station.

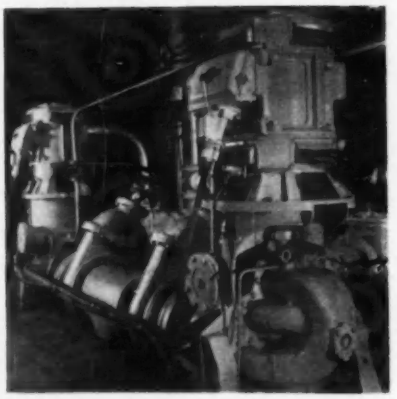


major units put into service overseas included the fourth 20-MW set supplied since 1945 for the China Light and Power Company's Hok Un station. In continental Europe, two units were commissioned for I.N.I. (Spain); a 30-MW hydrogen-cooled machine and a 15-MW air-cooled set, at Cadiz and Mallorca respectively.

Main generating plant ordered during the year from Metropolitan-Vickers for power stations in this country includes two 200-MW reheat turbines and water-cooled generators for Willington "B" (the condensers for which will each have a surface of 110,000 sq. ft.); and four supplied during the year included two 120-MVA three-phase 132/275-kV generator transformers for connection to the supergrid, while other units completed for the C.E.G.B. included 72-MVA and 60-MVA 132-kV transformers.

Technical developments in this field include improvement of design to reduce noise level in transformers, and preparation for the use of a digital computer for quick calculation in design problems. For distribution transformers, ordered in quantity during the year and now having dished covers with protected cover joints, a





(Left). The Metropolitan-Vickers 11.2-MW back-pressure turbo-alternator set supplied to Tate and Lyle Ltd., and installed in their works at Plaistow, London.

(Right). Metropolitan-Vickers 97-h.p. drip-proof squirrel-cage motors driving Drysdale extraction pumps at the Carmarthen Bay power station of the C.E.G.B.

80-MW mixed-pressure sets for Berkeley, the nuclear power station now being built in Gloucestershire by A.E.I.-John Thompson Nuclear Energy Co. Ltd.

Overseas orders included one from British Columbia Electric Company, obtained against competition from American, German and Swiss manufacturers, for six 150-MW 3,600-r.p.m. steam turbo-alternators for Vancouver, Canada; two 150-MW (max.) sets for Calgary Power Ltd., Canada; two 120-MW, 3,000-r.p.m. sets with auxiliary equipment, as part of the order for the complete Yallourn "E" power station of the State Electricity Commission of Victoria, Australia; two 66-MW, 3,600-r.p.m. sets, ordered by the Montreal Engineering Co. for Arriaga power station in Venezuela; and two 60-MW, 3,000-r.p.m. machines ordered by the Electricity Supply Commission of South Africa, for an extension to Umgeni power station, Natal. Orders have also been received from B.T.H. Export Co. Ltd. for the supply of condensing plant, feedwater heating and evaporating equipment, and associated auxiliaries for installation and service with a 30-MW turbine at Chamoun power station, Beirut, and with a 6.25-MW set at Merida power station, Mexico.

Transformers

In the new transformer factory at Wythenshawe, which was officially opened by H.R.H. Prince Philip on November 22nd, much new shop equipment has been installed for manufacturing and testing, and production has been maintained at a high level. The manufacture of rectifiers, previously a product of another department, was transferred to this factory during the year. Units machine was developed to wind coils on continuous strip-wound cores. Preliminary tests on a prototype 125-A circuit-breaker suggest a future demand for this as an overload protective device on the l.v. side of distribution transformers. Progress was made in the application of crimped terminals to transformers and a range for power cables is now stocked.

Power station auxiliaries

A new boiler-feed pump motor has been developed for an overseas contract and the design is available as an extension to the type HTAS range of machines. The new frame size is HTAS 12090 and for the particular order is rated at 700 h.p., 3,450 r.p.m. for use on a 4,160-V three-phase 60-c/s supply. Four different sizes of type HTAS motors can now be offered with outputs from 700 h.p. to 3,000 h.p. The company report much overseas business in connection with power station auxiliaries and important contracts received for C.E.G.B. power stations include orders from Hathorn Davey Ltd. for 23 high-speed motors ranging from 1,300-2,700 h.p., for driving Sulzer boiler feed pumps, and 12 840-h.p. auxiliary drive motors for South Denes (Great Yarmouth), Plymouth "B," Marchwood (Southampton), Skelton Grange and Uskmouth power stations respectively. From John Brown Land Boilers Ltd. orders were received for 24 motors from 435 to 883 h.p. for driving boiler auxiliaries; from Worthington-Simpson Ltd. for 15 pump motors from 100 to 175 h.p. for Staythorpe "B." Also, for John Brown Land Boilers Ltd. the company are supplying eight motors from 448 to 860 h.p. for driving the boiler fans at the Kincardine power station,

Fifeshire, of the South of Scotland Electricity Board.

For Berkeley nuclear power station detailed design and engineering work are well advanced for the instrumentation of the boilers and blowers ; development work on the unique system of computer display for burst slug detection equipment is now complete ; detailed design work for this is well under way.

Industrial generating plant

Nine turbo-alternators with an aggregate capacity of 63-MW commissioned for industrial firms during the year included a 20-MW condensing set and a 17-MW back-pressure set for Tate and Lyle Ltd., at Plaistow, London. Smaller sets, of 6.4-MW and 2.6-MW capacity were put into service for I.C.I. Ltd., at Witton (Kynoch) and Dowlais works respectively. Other small machines were commissioned for Thames Board Mills at Purfleet, for Bryant and May Ltd., for J. D. Crozier and Partners Ltd., as consulting engineers for Witchampton paper mill, and for Metropolitan Cammell Carriage and Wagon Co. Two generators were despatched to I.C.I. Thornton, of 23.4-MW and 15.5-MW respectively. Orders received during the year included a second 27.2-MW (1,600 lb./sq. in., 1,050 deg. F.) back-pressure turbine-alternator set for I.C.I., Wilton, two 1.0-MW sets for Vale Board Mills, a 1,627-MW turbine for Esso Petroleum Co., Fawley, and three 5-MW machines for the new steelworks at Durgapur, India. An electronic control equipment supplied with the 11.2-MW back-pressure set for Tate and Lyle, mentioned above, is, the company say, of unique design. The exhaust steam at 70 lb./sq. in. feeds into a main, which supplies (via a reducing valve), a large accumulator on which fluctuating demands are made for process steam. The control equipment varies the steam supply to the turbine as the accumulator pressure varies, according to a pre-set characteristic, and reduces this supply whenever exhaust pressure exceeds a predetermined value.

INCORPORATED PLANT ENGINEERS

The sixth annual dinner of Incorporated Plant Engineers was held at the Connaught Rooms, London, on February 21st, and was attended by about 150 members and guests. The principal guest speakers were :—Sir Cuthbert Clegg, M.A., T.D., J.P., chairman of Combined English Mills (Spinners) Limited ; joint managing director of Clegg & Orr Limited ; director of Martins Bank ; vice-president of the Cotton Spinners' & Manufacturers' Association, and a governor of Manchester University, and Major-General C. Lloyd, C.B., C.B.E., T.D., B.Sc., F.Inst.P., director of the City and Guilds of London Institute.

Proposing the toast to the Institution, Sir Cuthbert Clegg said that he had been much impressed by the range of subjects covered in the papers read to the monthly meetings of the Institution's branches. Any engineer who could claim a knowledge of all these subjects must surely be at the top of his profession. He had noted the Institution's refresher courses for senior works and plant engineers held at university level in one or more selected centres each year, and the plans to implement the productivity report on planned maintenance, written by the specialist team which visited the U.S.A. in 1952 and for which the Institution had been a sponsoring body. As a member of the Anglo-American Council on Productivity, Sir Cuthbert said that he had paid a number of visits to America and felt that both that country and ourselves could each learn much from the other. There was no doubt, however, that bigger work loads were achieved in America and he thought that this was largely due to the greater attention given to detail by management. He believed that as a result of the activities of bodies such as Incorporated Plant Engineers this closer attention was now being given in British industry.

In conclusion, Sir Cuthbert paid a warm personal tribute to the president, Mr. Vincent Taylor, and said that his company felt honoured that the Institution should have elected him to this office.

In his response, the president, **Mr. Vincent Taylor,** M.Inst.F., said civilisation had passed through the ages of wood, stone and metal and had witnessed the growth of engineering achievement culminating in the present atomic age. But perhaps the greatest marvel was man. Complete mastery of any one field of knowledge was today beyond the capacity of any individual and hence had arisen the need for specialisation and for teamwork to co-ordinate the activities of the specialist. A recent German book posed the question whether man's physical and mental equipment is equal to the demands of this technological age. The conclusion was that man is merely following his innate instinct to explore and advance to the limit of his capabilities ; he has by no means exhausted his latent ability. Our attitude to life and to our job, continued Mr. Taylor, is important. If our work brings us no joy we run the risk of many bitter disappointments. We are all concerned to do the best we can in whatever walk of life we find ourselves, and in whatever duties we undertake.

Mr. Taylor quoted Sir Winston Churchill as saying " Men make institutions and institutions mould men." Incorporated Plant Engineers was doing all it could to mould, encourage and guide future plant engineers. For the present plant engineer there were branch meetings and refresher courses, and he congratulated the Education Committee for its work in this latter field. For younger men and future plant engineers there was the City and Guilds Course in plant engineering.

It was interesting to note, continued Mr. Taylor, the age at which men became plant engineers. He had seen the records of a society extending back over 60 years and these showed that the average age at which an engineer took charge of a plant was 33. The plant engineer came to his job from one of many directions and it was to cater for these men that the Institution was founded.

This was a changing age and in order to cater for it the Institution itself would need to change. Progress had been made in the twelve years of the Institution's existence and there was a determination that further progress should be made. Incorporated Plant Engineers was growing and developing, and faced the future confident that it could continue in the spirit of those who had laid its foundations and of the great profession of engineering of which it represented but a fraction.

The toast of the guests was proposed by **Mr. James Wilson,** B.Sc., B.Com., J.P., Hon. M.I.Plant E., in a polished and witty speech. Mr. Wilson referred to the debt of gratitude that Incorporated Plant Engineers had incurred to many of the guests present.

In his response, **Major-General Cyril Lloyd** said that Incorporated Plant Engineers was a great professional institution and an important one because it was not confined to any narrow field of engineering but covered many fields over which it exercised a very necessary synthesising influence. It was right that the Institution's main concern should be with the professional and technical interests of its members, but he particularly welcomed the Institution's activities in the training and education of younger men and of technicians, and thanked it for its close co-operation with the City and Guilds of London Institute.

He believed that there was another great problem to which all of us needed to direct our attention at this time. This was in the education—in the broadest sense—of the ordinary citizen in matters scientific and technological. He had been particularly surprised at the sense of shock and distress which had been produced in a large number of people by the launching of the Sputnik. The general dissemination of scientific and technological knowledge would prevent this sense of shock when great events occurred and would make it possible for our fellow citizens—who ultimately control the government of the country—to make wise decisions. He believed that both physical and economic survival depended to a great extent on the education in science of the ordinary citizen.

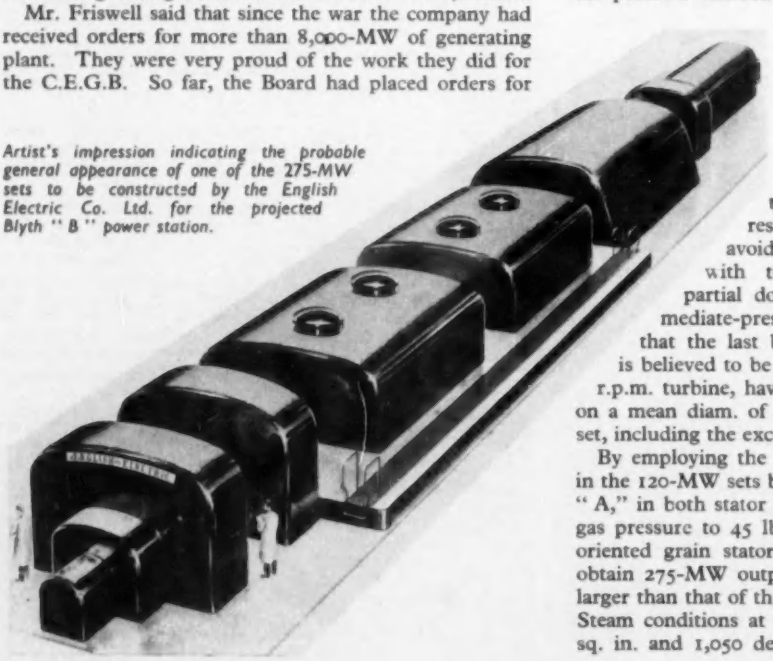
275-MW Turbo-Alternator Sets

AT a recent Press conference in London, Mr. A. Friswell, general manager of the Steam Turbine Division of the English Electric Company Ltd., announced that the company had received an order from the Central Electricity Generating Board for two turbo-alternators operating on the re-heat cycle, which will be the largest 50 c/s in-line machines in the world. These are the two 275-MW sets for the projected Blyth "B" generating station, and together with the associated condensing and feed-heating plant, the total cost of the sets will be more than £5 million.

This announcement shows the enormous strides that have been made during the past ten years in the design and manufacturing techniques of power generating plant. It was in 1948 that the first sets of 60-MW capacity were commissioned, to be followed by 100-MW sets in 1952, 120-MW sets and also 200-MW sets in 1955. It is considered in some quarters that with 275-MW machines, the limit is being reached—not through technical or constructional problems, but simply because the stators for sets of about this size represent the maximum load that is allowed to be carried on the roads of this country. Although sets of 550-MW are to be ordered (the contract for the boiler units to steam sets of this size has indeed been placed with International Combustion Ltd., as recorded in the March issue of this journal), these will comprise twin-shaft cross-compound units of 275-MW capacity. The English Electric Company's claim, therefore, that their 275-MW units are the largest single-shaft sets would seem to be justified.

Mr. Friswell said that since the war the company had received orders for more than 8,000-MW of generating plant. They were very proud of the work they did for the C.E.G.B. So far, the Board had placed orders for eight 200-MW sets, and five of these were being constructed by the English Electric Co. Ltd. They were the sets which would comprise the 1,000-MW of generating plant for High Marnham power station. They were now to make the 550-MW capacity (2 × 275-MW) for the projected Blyth "B" plant. These figures were most impressive when one considered that the company was only making 1-MW sets 50 years ago.

Reverting to the two 275-MW machines for Blyth "B," each unit will have a three-cylinder 3,000 r.p.m. reheat turbine with quadruple exhaust, arranged as a tandem compound unit coupled to a hydrogen-cooled alternator of the direct-cooled type. The appearance of the completed machine will be somewhat different from many of the large sets now installed, as the steam from the medium-pressure cylinder will be led to the two low-pressure cylinders by ducts that run along the side of the set instead of over the top. The quadruple flow l.p. cylinder will be arranged in two double-flow l.p. casings each exhausting to one of the two condensers forming the twin condensing unit. Solid couplings will be fitted between cylinders, and each shaft will be mounted on two main bearings to give ease of assembly and maintenance. The general arrangement of the machine is thus generally similar to the company's 200-MW units. The first six stages of the high-pressure cylinder are contained in a double casing with the expanded steam returned between the walls to pass over the remaining stages. These features together enable the pressure differences and operating temperatures in the metal to be reduced, compared with those encountered in single-casing design. Ferritic materials can therefore be used. Castings have been employed for the steam chests and cylinder casings in preference to forgings, as they provide a more uniform thickness of material, and corresponding thermal response, thus avoiding transient distortion associated with temperature changes. A similar partial double-casing is used for the intermediate-pressure cylinder. It may be noted that the last blade of the low-pressure cylinder is believed to be the largest in the world on a 3,000 r.p.m. turbine, having a length of 36-in. and running on a mean diam. of 100-in. The overall length of the set, including the exciter, will be about 140-ft.



Artist's impression indicating the probable general appearance of one of the 275-MW sets to be constructed by the English Electric Co. Ltd. for the projected Blyth "B" power station.

By employing the direct-cooling system, as first used in the 120-MW sets built by the company for Willington "A," in both stator and rotor, by raising the alternator gas pressure to 45 lb./sq. in. and by using cold-rolled, oriented grain stator coreplates, it will be possible to obtain 275-MW output from a frame size only slightly larger than that of the 200-MW sets for High Marnham. Steam conditions at the turbine inlet will be 2,300 lb./sq. in. and 1,050 deg. F. There will be one stage of

reheat to 1,050 deg. F., and 565 lb./sq. in. It is estimated that the final feed temperature will be 486 deg. F., when the machine is operating at maximum output.

The feed-heating system has seven bled-steam stages comprising three surface-type l.p. heaters, followed by a high-level storage deaerator of the direct-contact type, and by three high-pressure feed-heaters of the surface type. The last high-pressure heater will be split into two units arranged in parallel. The feed system employs dual pumping, the three high-pressure heaters being interposed between the booster feed pump and the main boiler feed pump. The latter will probably be driven from the end of the turbo-alternator shaft through a variable-speed fluid coupling, and motor-driven starting and standby boiler feed pumps will be provided.

The condensing plant will comprise twin-shell units having a total surface of 165,000 sq. ft., and designed to maintain the designed absolute pressure of 1-in. Hg. when supplied with 110,000 g.p.m. of cooling water at a temperature of 52 deg. F.

Steam for the turbines will be provided by two boilers, (one for each set) and to be built by Yarrow & Co. Ltd., Glasgow. Each boiler will have a maximum evaporative capacity of 1,900,000 lb./hr., at a pressure of 2,400 lb./sq. in. and final temperature of 1,055 deg. F. They will be of the controlled circulation type, with twin furnaces for burning pulverised coal. Supplies will probably be drawn from the Yorkshire area, and when operating at full rating the consumption per boiler will be between 115 and 135 tons/hr. One furnace will control the main steam temperature and the other the re-heat steam temperature. There will be six p.f. mills serving each boiler furnace, with an additional mill for standby purposes. Each boiler with its associated pulverising plant, economiser, air-heater fans, electrostatic precipitators, etc., will occupy a floor area approximately 150-ft. by 375-ft. The height to the top of the boiler will be about 165-ft.

The use of large and more efficient generating sets of two, three and four times the capacity of the standard sets of a few years ago—effects great economies in construction and generation costs. This policy of installing progressively larger sets is the reason for power stations today costing no more (per kilowatt installed) to build than those of ten years ago, despite considerable increases in building material prices and labour costs, some of which have almost doubled. The use of large unit sets also effects considerable savings in the size of building needed. A modern 360-MW station having six 60-MW sets and unit boilers, requires about 28.5 cu. ft./kW installed, while the projected 1,100-MW station at Thorpe Marsh (two 550-MW sets and two 3.75 million lb./hr. boilers) will, it is estimated, occupy only 12.6 cu. ft. per kW.

GAS FROM LOW-GRADE COAL

In view of the decreasing supplies of coal suitable for producing gas by conventional methods of carbonisation, considerable interest will be attached to the recent announcement by the Scottish Gas Board that a Lurgi pressure-gasification plant, capable of producing gas from low-grade coal containing up to 25 per cent. ash and 16 per cent. moisture, is to be erected for them by Humphreys and Glasgow Ltd., in association with the Power Gas Corporation.

The new plant, which is expected to cost £6½ million, will be built adjacent to the Westfield, Kinross opencast coal site of the National Coal Board, from which source it is estimated there is sufficient coal of the type required, to supply the Lurgi generator for a period of some twenty years. Construction of the plant will take place in two stages, and when completed in September, 1962, the installation will have a capacity of 30 million cu. ft./day. By July, 1960, however, when the first stage is expected to be in operation, the capacity will be half this figure—15 million cu. ft./day.

Coal will be transferred by conveyor from the open-cast site to the Lurgi plant, where it will be completely gasified at a pressure of 25 atmospheres in a continuous stream of oxygen and superheated steam. Before use the coal will be crushed and screened—that for the gas generators being sized ¼-1¼ in., and that for the steam raising unit associated with the process, ¼-in. to minus 1-in. Ash collected from both the gas generators and the steam-raising unit will be returned to the open-cast site for back-filling. The oxygen required for the gasification process will be obtained from two air-separation plants, which will also produce the nitrogen necessary to adjust the combustion characteristics of the gas.

In the initial stage (15 million cu. ft./day) the gas proudced will have a calorific value of 400 B.Th.U./cu. ft., and this will be raised by enrichment with butane to the normal 450 B.Th.U./cu. ft. before distribution. When, however, the complete plant is in operation the gas will be enriched to about 700 B.Th.U./cu. ft. by hydrogenation of oil—a process developed by Dr. F. J. Dent of the Gas Council's West Midlands Research Station, where Humphreys and Glasgow Ltd., have already built a 1 million cu ft./day pilot plant for the study of this process. In this instance the gas will, as mentioned above, be diluted with nitrogen prior to distribution.

The Lurgi process allows for the recovery of tar, light oils, ammonia and benzole from the crude gas before it passes to a catalytic conversion plant where the proportion of hydrogen in the gas is increased. Carbon-dioxide will then be removed in a "Benfield" plant, and the gas enriched by the hydrogenation process before it passes to a further benzole plant for the recovery of high-purity benzene, and finally through pressure oxide purifiers to remove the final traces of hydrogen sulphide.

The boiler plant to be installed to meet the steam requirements of the Lurgi process will have a capacity of 150,000 lb./hr., at 450 lb./sq. in. and 680 deg. F., steam from this source also being utilised for driving a 7,150-kW turbo-alternator. The necessary steam for the "Benfield" plant will be supplied from waste-heat boilers integral with the Lurgi process, and which obtain heat from the crude gas as it passes from the gas generators.

The General Electric Co. Ltd. announces that **Mr. R. N. Millar** has been appointed general manager of the company's Fraser & Chalmers Engineering Works at Erith, Kent. Mr. Millar has been manager of the company's Atomic Energy Division since its establishment three years ago. He will still be responsible for the company's activities concerning the manufacture of nuclear power plant, but he will be assisted in this field by **Dr. K. J. Wootton,** who will succeed him as manager of the Atomic Energy Division. Mr. Millar was educated at Marlborough College and, after serving an engineering apprenticeship at the Fraser & Chalmers Engineering Works, went to Emmanuel College, Cambridge. After the war, during which he served in the Royal Navy as an engineer officer, he became an assistant mechanical engineer to the British General Electric Co. in South Africa, and while there obtained a degree in economics and industrial administration. In 1952, Mr. Millar was appointed chief mechanical engineer to the B.G.E. Co. in Sydney, Australia. Towards the end of 1954 he was recalled to take charge of atomic energy developments in the G.E.C.-Simon-Carves Atomic Energy Group. Dr. Wootton was educated at Watford Grammar School and Imperial College, London, where he obtained a first-class honours degree in mechanical engineering. During the war he was commissioned in the R.A.F. Technical (Engineering) Branch. After the war he returned to Imperial College for three years to carry out research work in connection with heat transfer, and then joined Vickers-Armstrongs Limited as a research and development engineer.

Pulverised-Coal Firing of Shell-Type Boilers

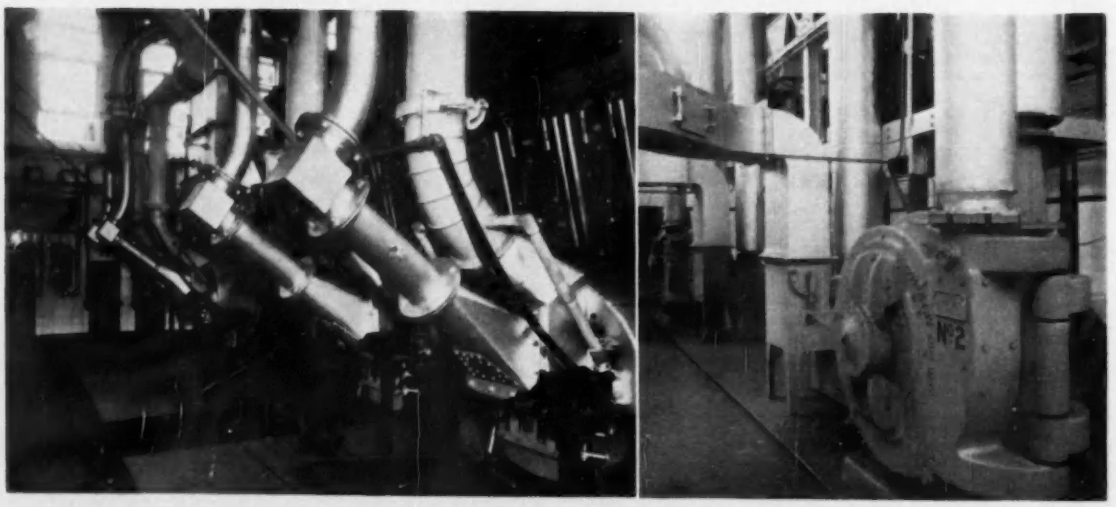
DURING the past ten years a system of firing shell-type boilers with pulverised-fuel, using the Atritor dryer-pulveriser manufactured by Alfred Herbert Ltd., has been successfully operated, and recently we were invited to see the latest installation of this type which is used to provide the space-heating requirement of the company's machine tool factory at Lutterworth. The boiler plant was commissioned in September, 1956, and comprises two 21-ft. × 9-ft. Davey, Paxman double-pass Economic-type high-pressure hot-water boilers, rated at 9,000 lb./hr. at 150 lb./sq. in. and 212 deg. F.

Adjacent to the new boiler house there is a covered coal-storage area, where a Duplex crusher, capable of handling coals of sizes up to 6-in., and reducing it to ½-in. at the rate of 10-ton/hr., discharges into an elevator connected to twin overhead bunkers each of 20-ton capacity. From the bunkers, the raw coal is discharged through an off-set chute into the Atritor feeders which are controlled from the front of the boiler by a rheostat. The coal leaves the feeders at a pre-determined rate and enters the ascension pipes where partial drying takes place as the coal is conveyed by a stream of hot gas, taken from the boiler combustion chambers, into the Atritor dryer-pulverisers. Here, final drying is achieved at the same time that the coal is pulverised to the requisite fineness. Prior to entering the pulverisers the coal passes in an upward direction, and at such a velocity that tramp iron and similar heavier materials are separated and drop out of the machine via a discharge chute.

The Atritor units are of 2,000 lb./hr. capacity, and they are located at the rear of the boilers, thus leaving a perfectly clear firing-aisle. An integral fan delivers the coal, which is mixed with secondary-air for correct combustion, to two multi-jet burners positioned in the boiler flues. Ignition is obtained rapidly by means of a gas-torch, and a demonstration of lighting-up, staged during our visit, showed that stable conditions with 12 per cent. CO_2 could be achieved within 15 min. from cold.

Soot-blowing equipment supplied by C. P. Parry Ltd. is made integral with the burners for cleaning the two main boiler flues, while equipment supplied by Clyde Blowers Ltd. is incorporated in the rear of the combustion chamber to clean the back plate and return tubes. This arrangement, of course, applies to Economic boilers, and it was pointed out that for Lancashire boilers fired by this system the blowers are positioned in the fire-tubes, flame-bed and side-flues respectively. Dependent upon the ash content of the fuel used, blowing once or twice during a shift is, the company say, sufficient to keep the boiler clean for a normal heating season. Ash should be removed from the combustion chamber of Economic boilers once or twice a week.

An instrument panel fitted with a full range of instruments supplied by George Kent Ltd. is provided for normal boiler control. In a separate structure at the front of the boiler house are two tubular-type dust-collectors, manufactured by Prat-Daniel (Stanmore) Ltd. These collect grit from the flue gases which then pass to a 100-ft. high brick chimney. Other ancillary equipment includes a G. & J. Weir Ltd. steam-driven vertical feed-pump and an electrical-driven centrifugal feed-pump, supplied by Sigmund Pumps Ltd., Gateshead. Sited adjacent to these latter units are two hot-water circulating-



(Left). Front view of the two Davey, Paxman pulverised-fuel-fired double-pass Economic-type hot-water boilers installed at the Lutterworth works of Alfred Herbert Ltd. (Right). The two Atritor dryer-pulverisers which are located at the rear of the boilers. This view also shows flue-gas ducting and fuel supply pipes serving the Atritor units.

pumps manufactured by Holden and Brooke Ltd. and supplied to the order of the Sturtevant Engineering Co. Ltd., who were responsible for the factory space-heating installation.

The flexibility resulting from the use of p.f. firing makes it possible to follow a fluctuating steam load without difficulty, and the duty of the boiler operator is simply confined to a periodic check of conditions, maintenance being restricted to a period when load requirements are at a minimum. Dealing further with the important question of maintenance, Alfred Herbert Ltd. say they have experienced an exceptionally long life from the combustion-chamber brickwork of p.f. fired Economic boilers. Two such units which they operate in the Coventry area, for example, have furnace brickwork that has been in service for more than ten years, and which is still in extremely good condition. With this in mind the company have used hot-face insulation brick for this purpose in the new boilers at Lutterworth, by which means they claim that a quicker face heat is obtained, with the result that there is less smoke emission from the stack during starting up periods.

A further point, and one that was very evident at Lutterworth, is that this type of installation can be kept extremely clean, due to the fact that both the coal-handling and the firing equipment is completely dust-tight. In addition, there is no unpleasant odour as experienced with some fuels—an important consideration when planning boiler plants for the food manufacturing and allied industries.

General details of dryer-pulveriser

The Atritor dryer-pulveriser pulversises entirely by attrition, hence its name. It is a self-contained unit consisting essentially of a feeder, pulveriser and fan, and is manufactured in a range of sizes designed to enable unit firing to be adopted for even quite small heating requirements. The system is well suited to the firing of shell-type boilers with low-grade fuel—virtually any grade above 18 per cent. volatile content being suitable, while still allowing full flexibility and a high efficiency. An example quoted by the company concerns a Lancashire boiler fired with slurry containing 25 per cent. moisture and 25 per cent. ash, which now obtains evaporations of 11-12,000 lb./hr., without an economiser, compared with 4,000 lb./hr. when the unit was hand fired.

The dryer-pulveriser is compact and, as it operates with little or no vibration, requires comparatively simple and inexpensive foundations. The replacement of parts was the subject of special attention during the design stage, while maintenance generally is of low cost per ton, due not only to design features, and the special metals used in the construction of the grinding components of the pulveriser, but also to the modest speed of operation relative to other types of mill.

Finally, it should be noted that while the cost of a p.f.-fired boiler installation, similar to that described earlier in these notes, is much greater than would be the case for one incorporating stoker or oil-firing, Alfred Herbert claim that from their own experience, savings up to 25-30 per cent. on fuel costs can be expected, due to the high efficiencies obtainable and the fact that even low-grade fuels may be utilised.

Although the application of the Atritor dryer-pulveriser to the firing of shell-type boilers is a comparatively recent innovation, perhaps it should be recalled here that during the past 25 years the company have supplied a large number of these units for use with every type of water-tube boiler, while they have also been responsible for the supply and erection of complete boiler installations, including coal-handling plant, boilers and pulverising equipment. Atritor pulverisers are, of course, well-established in connection with the firing of rotary cement and lime kilns, and various types of industrial furnace, while they are also used to a very large extent for the controlled drying and grinding of many materials other than coal.

Lockheed Hydraulic Control Equipment at Barony Power Station

In the March issue of this journal we published an illustrated description of the Barony power station of the South of Scotland Electricity Board. The Babcock & Wilcox boilers at the station have furnaces designed to burn slurry, or dry fine coal, or a mixture of slurry and fines. As pointed out in our description of the plant, Babcock 35-ton rotary hoppers are installed near the fuel storage area, and these feed the first of a system of belt conveyors which transport the slurry to the rotary hoppers in the boiler house. These latter hoppers feed the slurry to beater-type pulverising mills.

For these mills, Lockheed hydraulic controls are employed—not only for the dampers which control (a) the supply of cold air for attemperating hot air ; (b) hot air for attemperating hot gas, and (c) the damper for the hot gas tapping—(the latter operating in conjunction with an automatic damper for the control of cold air attemperating hot gas to mill)—but also for the operation of the plough blades of the 35-ton rotary slurry hoppers.

The hydraulic controls afford automatic closing of the dampers in the event of mill motor failure, and also for the automatic withdrawal of the plough blades, the latter operation being controlled in such a manner that there is no chance of any pile up or jamming of material taking place.

With the mill motors running, the dampers are under control by push-buttons, and additional interlocking is provided so that the damper for cold air attemperating the hot air supply to the mill must be open before the others can be opened, and before the plough blades can be operated ; these latter being positioned as desired by hydraulic cylinders under control from the handle of a metering and reversing valve.

The Lockheed control system employs a pressure source incorporating accumulators for the storage of hydraulic power to ensure rapid closing of the dampers in the case of mill motor failure. Accumulator capacity is sufficient to provide for the closing of all the twelve dampers involved in the event of stoppage of all the four mills serving each boiler. The system provides also for the usual hydraulic control of air-heater air isolators, and the recirculating-air and air-heater bypass dampers of the boilers.

An Improved Single-phase Motor

NEWMAN Industries Limited, Yate, Bristol, are manufacturing a new range of single-phase induction motors. The company states that the new motor has been designed specifically for single-phase duty, and therefore for optimum performance and reliability. It is *not*, as may be assumed, a modified three-phase motor. It is a drip-proof enclosed capacitor-start, induction-run machine :— the most apparent improvement being the absence of the condenser which is usually mounted on the top of this type of motor. By using condensers specially designed for the purpose and concealing them in the motor feet, a compact, easily-cleaned and modern appearance has been achieved. A fairly high starting torque is provided, but at the same time, the current limitations of single-phase supplies generally has meant that starting current has had to be kept as low as possible but consistent with the torque requirement.

It is a well-known fact that single-phase motor design is hampered by the starting current restrictions of single-phase supplies ; but the company claims that the torque/current ratio for this new motor is the best compromise for most applications where single-phase motors are used.

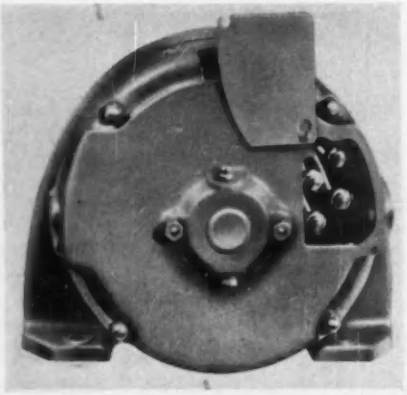
Ultimately, the range will be from ½ to 5 h.p. in two-, four- and six-pole speeds, but the sizes immediately available are 1, 1½, 2 and 3 h.p., four-pole for 50 or 60 c/s supplies.

A great deal of research into materials, designs and methods of production of this new motor has been carried out, as well as destructive tests. This particularly applies to the centrifugal switch upon which more than anything else, the reliability of a single-phase motor depends.

One of the most unsatisfactory aspects of a capacitor-start motor is, perhaps, the usual necessity to mount the condenser externally, where not only is it vulnerable to accidental damage and vulnerable to dust, but also it considerably adds to the overall dimensions. The condenser is divided into two small units and accommodated in the motor feet. The condenser units are completely enclosed in aluminium canisters which in turn are further protected against moisture by an insulating case. Small spring clips firmly hold the condensers in position. The centrifugal switch is totally enclosed, and the dust-tight moulded housing contains the solid silver contracts comprising the static portion of the switch. This is mounted in the non-drive end bracket. The rotating part of the switch is built of interlocking pressings so that there are no hinge pins or other seizable parts. This part of the switch is housed in the hub of the fan so that it is shrouded and protected by the fan itself against any dust that may be drawn into the motor.

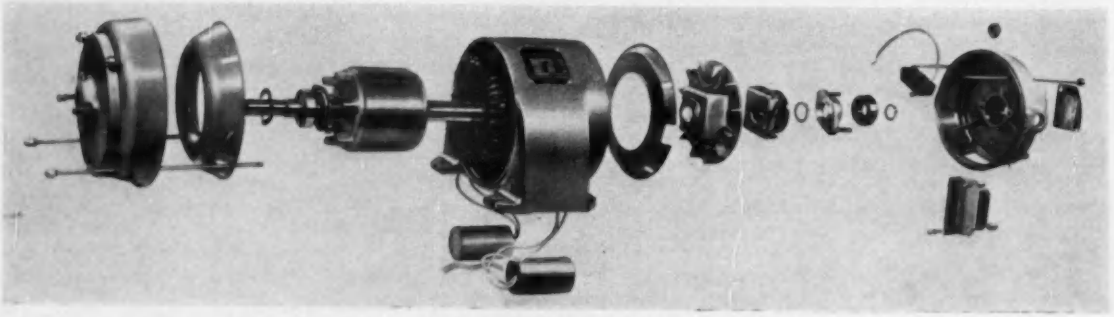
Ventilation is arranged to give maximum cooling efficiency combined with a high degree of protection against dust or moisture. Air is drawn in at the underside of the drive-end bracket, passed axially through the motor and exhausted at the underside of the non drive end bracket. A pressed steel baffle is arranged to exhaust the air from the motor in *front* of the fan.

The non-drive end bracket is so designed that it can be supplied with the conduit entry on the right- or left-hand side of the motor. A cover plate on the face of the end bracket gives direct access to the moulded terminal block and stud-type terminals. Terminal

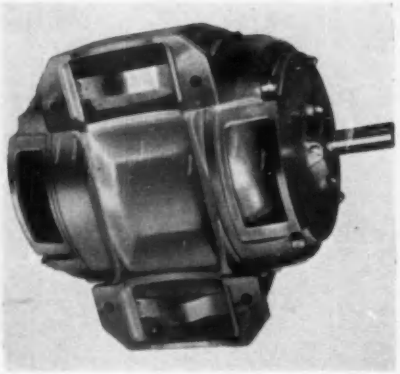


(Above). View of the new motor showing terminal box contained within the non-drive end bracket with access through the cover plate.

(Below). Exploded view showing components of Newman single-phase motor.



markings are permanently engraved. Provision is also made in the end bracket casting to accommodate a thermal overload protective device (which may be auto or manual reset) when required. Dimensionally, the motor is to NEMA (American) standards. The bearings are standard metric sizes and are lightly pre-loaded to ensure quiet vibration-free running.



Underside of Newman single - phase motor showing the twin condensers accommodated in feet of casing.

At a press reception held at Yate recently to mark the introduction of this new range of motors, Mr. Hedley Newman (assistant managing director, Newman Motors Ltd.), explained that during the past 12 years the company has developed a number of complete new ranges of motors, each specially suitable for the particular industry, duty, climate or local conditions. Parallel with all these developments the range of sizes has been increased, and Newman now manufacture units of up to 600 h.p.

The export field has received particular attention and last year the firm became the only manufacturers outside of Canada and the U.S.A. to have the approval of Underwriters Laboratories Inc. for explosion-proof motors for use in the U.S.A. Thus with British Buxton certification Newman Industries Ltd. have catered for explosion and flameproof conditions throughout the world.

NEW BRITISH STANDARD

In the November issue of this journal we made reference to Parts 1-4 of the new British Standard—B.S. 1016 : 1957 —" Methods for the analysis and testing of coal and coke." Part 5, which marks another stage in the revision of B.S. 1016 has recently been issued. As was the case in B.S. 1016 : 1942, the basis of the methods is the burning in oxygen at constant volume, in a bomb calorimeter of known heat capacity, of coal and coke ground to pass a 72-mesh sieve. But it should be noted that a number of modifications have been made to the original method. The reference temperature is now 25 per cent. Thermometers of the fixed-scale type and of a high standard of accuracy are specified ; Beckmann thermometers are no longer permitted. The permissible materials from which the components of the bomb calorimeter may be manufactured are specified, in order to eliminate the risk of failure due to intercrystalline corrosion. For coals, an initial oxygen pressure of 25 atmospheres (gauge) is specified. For anthracite the pressure may be increased to 30 atmospheres (gauge) and this pressure may also be necessary for coals and cokes that do not burn completely at the lower pressure, particularly in bomb calorimeters of smaller capacity. The crucibles specified for coke differ in dimensions from those for coal. The method of determining the effective heat capacity (water equivalent) of the calorimetric system has been specified more closely. A special nickel-chromium foil crucible is recommended for use if difficulty is experienced in obtaining complete combustion of benzoic acid when using crucibles of the type specified for coal. Either the Regnault-Pfaundler or the Dickinson formula may be used for calculating the cooling correction ; an example showing the calculation with each formula is included. Copies may be obtained from British Standards Institution, 2, Park Street, London, W.1. Price 6s.

Smoke Density Indicator. A simple smoke density indicator, developed by the Fuel Research Station of the Department of Scientific and Industrial Research, is now available from Shandon Scientific Co. Ltd., 6, Cromwell Place, London, S.W.7. It consists of a special glowing element (known as the " Glowring ") placed in the side flue and which is viewed through a column of flue gas from an observation window in the front wall of the flue. The brightness of the " Glowring " can be adjusted, so that it is obscured when the smoke density corresponds with No. 2 shade on the Ringelmann chart. This is the density which, under the Clean Air Act, must not be exceeded. In this equipment, except for the observation window which is easily accessible, there are no mirrors or glasses to be cleaned. It will be appreciated that the flowing element is self-cleaning as any deposits on it are burnt off.

* * *

Coincident with the announcement that the Canadian subsidiary of **George Kent Ltd.**, Luton, has been awarded the contract for the instrumentation of Units 1 and 2 for the Boundary Dam thermal generating station, Saskatchewan, we are informed that the name of this subsidiary company, previously Kent-Norlantic Ltd. has been changed to George Kent (Canada) Ltd., the address for the offices and plant remaining unchanged at 389, Horner Avenue, Toronto, 14. Their sales and service organisation covers the whole of industrial Canada, with branch offices in most provinces. The address for Quebec province is George Kent (Canada) Ltd., 1176, Sherbrooke Street West, Montreal, and that for British Columbia, George Kent (Canada) Ltd., 2760, West Broadway, Vancouver, B.C. The agents for the provinces of Manitoba and Saskatchewan are Mumford, Medland Ltd., 575, Wall Street, Winnipeg, and Albert and Fifth Avenue, Regina ; and the maritime agents, Purves Industrial Sales, 19, Belmont Road, Halifax, Nova Scotia.

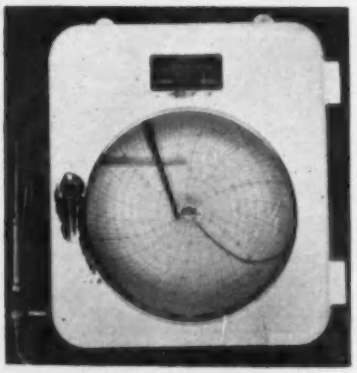
Mr. Hector McNeil, B.Eng., M.I.Mech.E., M.I.E.E., F.Inst.F., has been appointed managing director, Babcock & Wilcox Ltd., in succession to **Sir Kenneth Hague,** M.I.Mech.E., M.I.E.E., who has expressed the wish to relinquish that position, which he held since January, 1945. Sir Kenneth will continue to devote his services fully to the company in his position as deputy chairman. Mr. McNeil, who was born in New Zealand in 1904, joined Babcock & Wilcox Ltd. in London in 1931 as a service engineer. He was appointed engineer in charge of heat briquetting in 1935, and deputy chief engineer in 1938. In 1947 he was appointed general manager of the company, in London, becoming a director in 1950 and deputy managing director in 1953. He is also a director of Dewrance and Co. Ltd., and of the German, Spanish and Australian Babcock & Wilcox Companies. Since 1953 he has been a Member of Council of the Institute of Fuel, was vice-president of that Institute from 1953 to 1956 and became president in 1957. **Mr. J. Stewart Robertson,** general manager, has been appointed a director of the company to fill the vacancy created by the retirement from the board, at his own request, of **Mr. C. H. Sparks,** who has been a director for the past 18 years. Mr. Sparks will continue in his present capacity as engineering consultant to the company. Mr. Robertson joined Babcock & Wilcox Ltd. in 1935 after an apprenticeship with the General Electric Company Ltd. After gaining experience in the erecting and service departments, he was on the staff of the company's Calcutta office until 1940, when he went on military service with the London Scottish, and the City of London regiment of the Royal Fusiliers until 1945. From 1946 to 1950 he represented Babcock & Wilcox Ltd. in New York and on his return to London was appointed manager of the Commonwealth sales department. He became assistant general manager in 1952 and general manager in 1953.

Instruments, Electronics, and Automation Exhibition

The Instruments, Electronics and Automation Exhibition is being held at Olympia, London, from April 16th to 25th. The instruments and instrument equipment being exhibited cover every field of instrumentation in industry, research and education. A conference, in which leading experts on the technique of instrumentation, etc., will participate, is being held concurrently with the exhibition.

The Accurate Recording Instrument Co. Ltd., *Brooklands Works, Dartford, Kent*

The Accurate Recording Instrument Co. Ltd., exhibits will include standard and differential-pressure gauges of the Bourdon tube, bellows and diaphragm-actuated types ; temperature indicators of the liquid-expansion fully-compensated, head-compensated and vapour-pressure actuated systems ; and tank contents gauges of the constant-reading sealed-system and the air-purge system, with single- and multi-readings. Among other temperature recording and controlling equipment will be temperature recorders of the single- and twin-pen type, with liquid-expansion fully-compensated, mercury-in-steel and vapour pressure actuated systems ; temperature indicating and recording controllers with fully-compensated liquid expansion systems fitted with up to four mercury switches with adjustable settings. Other instruments included in the display are mains-operated remote electrical tele-reading instruments for local and remote reading of pressure, temperature and vacuum.



Typical example of an "Accurate" temperature recorder.

Bailey Meters & Controls Ltd., *Purley Way, Croydon*

Among the equipment exhibited by Bailey Meters & Controls Ltd., will be a fully transistorised 5-in. strip-chart recorder for use with temperature and telemetering equipment ; a two-position alarm—the Bailey high-precision transistorised controller type-P4, designed to operate as an on/off controller or alarm unit ; a trip margin indicator consisting of two modified type-P4 controllers and a miniature 4-in. scale indicator, for use where indication approaching alarm set point is required ; a miniature electro-pneumatic strip chart recorder, which offers a complete range of application, since in the same size and same appearance case it is possible to install pneumatic or electronic receivers or a combination of both. There will also be shown a 5-in. electronic self-balancing strip chart recorder ; a photo-electric two-position controller, consisting of a standard Bailey 8-in. scale indicator receiver, and incorporating a photo-electric cell for on/off alarm warning ; and a rate-of-change temperature recorder—a slightly modified version of the Bailey Calortron recorder and a specially designed thermocouple assembly. For measurement of the amount of oil in boiler feed-water, a compact Bailey oil-in-water detector and recorder will be exhibited, and other equipment on show will include the Bailey operations recorder, flow meters, smoke-density equipment, metering equipment, draught gauges, telemetering equipment, temperature equipment, panels and console desks.

Black Automatic Controls Ltd., *Lenfield, Corsham, Wilts*

Representative examples of control units selected from the Black Automatic Controls Ltd. range of solenoid gas valves, oil valves, diaphragm valves, control valves and pressure switches will be exhibited. The company's range of solenoid-operated oil-fuel valves includes types suitable for use with practically every variety of oil-burning appliance. Sizes range from ¼-in. BSP, for use with small oil-burners, up to 1-in., fitted with heavy-duty solenoids for use with high-viscosity oils and in pre-heated circulating systems. A new design of solenoid-operated lever-valve, specially developed for high-viscosity, high-temperature fuels, will be featured. A new range of diaphragm valves will be displayed in sizes up to 3-in. BSP, which are intended particularly for handling a wide range of industrial liquids including high-viscosity fluids such as grease, wax, etc. Control valves to be exhibited will include high-pressure three-way and four-way valves for pneumatic and hydraulic control applications at pressures up to 5,000 lb./sq. in. An extended range of pressure and vacuum switches will also be exhibited.

The British Rototherm Co. Ltd., *Merton Abbey, London, S.W.19*

The British Rototherm Co. Ltd. will be exhibiting bi-metal actuation, rigid stem thermometers with a variety of dial sizes, temperature ranges, presentations, stem lengths and diameters, together with max./min. and control/alarm thermometers for most engineering, marine and laboratory purposes. Other items are covered by the general headings mercury-in-steel thermometers ; vapour pressure thermometers ; mercury-in-steel temperature recorders ; temperature controllers ; pressure recorders ; and pressure, vacuum, altitude and hydraulic gauges.

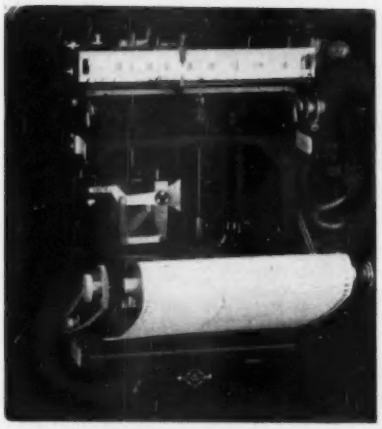
The British Thomson-Houston Co. Ltd., *Rugby*

Among exhibits at the British Thomson-Houston stand will be the "Emotrol" (electronic motor control) system which provides exact stepless speed control, and is available in two basic forms :— (a) electronic power control of machines, in which the electronic valve circuit is essentially a power rectifier taking current from an a.c. supply and delivering armature and field power to a d.c. motor ; and (b) electronic regulation for speed control, in which the electronic apparatus provides regulating action to a machine to alter its speed or other characteristics, through the medium of a Ward-Leonard system. The range of "Emotrol" units covers ratings from ½-600 h.p. Other items from the company's range of electronic products for industry and research include a general-purpose induction heater (type FA27A) ; an electronic voltage regulator (type FV29), for generators of ratings up to 5,000 kVA ; an infra-red radiation pyrometer (type TRP2) ; vibration measuring equipment ; gas-leak detectors ; frequency meters ; an infra-red relay for flame control ; and resistance welder controls. Demonstrations will show the industrial applications of photo-electric cells and electronic timers.

Cambridge Instrument Co. Ltd., *13, Grosvenor Place, London, S.W.1*

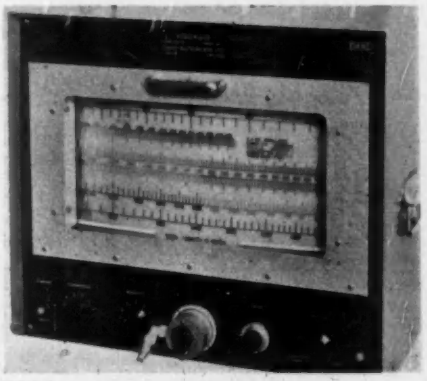
The Cambridge Instrument Co. Ltd. will exhibit a comprehensive selection of instruments designed to fulfil measure-

ment and/or control functions in almost all types of industry. Of special interest are the following new instruments, all of which are either in the final prototype stage or already in production :— (1) An electronic conductivity recorder—a direct-writing, continuously running, mains-operated instrument of high sensitivity, with a built-in amplifier and compensation for quadrature error. (2) An electro-chemical dissolved-oxygen

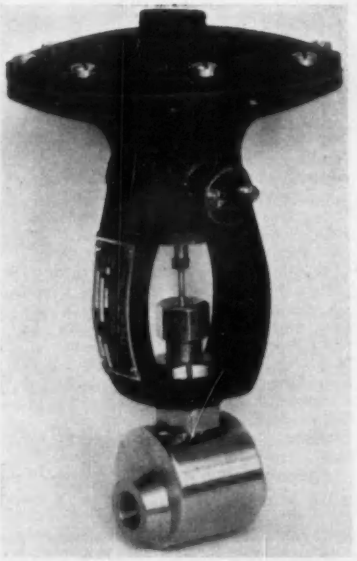


(Left). Typical example of a Cambridge "DE" electronic recorder/controller arranged as a single-point pneumatic proportional controller.

(Right). The Dawe Instruments Ltd. type 1108 Visigauge.



(Below). A Crosby diaphragm-operated control valve for low-capacity applications.



analyser (gas-phase transfer type)—a continuously recording and analysing outfit which is specific for oxygen, employing a novel electro-chemical method of detection designed to meet the requirements of modern high-pressure and high-temperature steam systems now employed in nuclear and other types of power stations. (3) A residual hydrazine recorder which is employed with boiler feed plants where hydrazine is used to remove dissolved oxygen from boiler feedwater. The unit consists of an analyser cell through which the feedwater is flowing continuously. An electrolyte is fed into it from a small reservoir, in order to give a small conductivity to the water. The measuring cell contains two electrodes between which a small fixed potential is applied. In the presence of hydrazine a current will flow through the cell, and is proportional to the hydrazine content of the solution. Externally, this current passes through a variable resistor across which the potential difference is measured by means of an electronic recorder. To check calibration, a further reservoir is fitted, from which a known concentration of hydrazine can be added to the water ; the sensitivity is then adjusted by altering the value of the variable resistor.

Coley Thermometers Ltd., *Bryco Works, 2-4, London Road, Brentford, Middlesex*

On this stand will be exhibited a series of vapour-pressure and mercury-in-steel thermometers in a number of models, dial sizes, and ranges. Electric-contact thermometers, temperature controllers and recorders with vapour-pressure and mercury-in-steel actuation will also be shown, together with thermo-couple pyrometers, electric-contact and temperature control pyrometers.

Crompton Parkinson Ltd., *Crompton House, Aldwych, London, W.C.2*

The central feature of this stand will be the company's new circular scale portable instruments which have 11-in. scales extending over 240 deg.—in a standard 8-in. square case. This range of instruments was recently extended and now includes single- and multi-range ammeters, voltmeters and wattmeters, as well as frequency, power factor, and speed indicators. Also shown will be the well-known "Universal" indicator scaling which enables a very wide range of voltage and current measurements to be made on the one instrument, using standard shunts and series resistance bobbins. A working display will demonstrate features of the Crompton Parkinson electrical tachometer, which by the use of a three-phase generator enables even very slow speeds to be indicated without needle flicker or "cogging." Other items will include special instruments of the shock-resistant and sealed-types, and the "Tong Test" portable ammeters, which permit current measurements to be made without breaking a circuit. The display will also include a representative selection of instruments for industrial and marine applications.

Crosby Valve & Engineering Co., *Crosby Works, Ealing Road, Wembley*

A number of working exhibits will be featured on this stand, including four valves with special plastic bodies to illustrate the "path-of-flow" through the Mason Neilan percent piston control valve and angle control valve ; the Mason Neilan type-107 valve for small flows ; and a Crosby relief valve. This latter set-up will also include a Mason Neilan 12000-series displacement-type level-controller/transmitter and double-seated control valve. Other demonstration units incorporate two different types of Mason Neilan pressure controllers ; the type-76 safety lock-up valve ; and a Crosby full-nozzle, full-lift standard relief valve and a Mason Neilan type-2807 pressure controller and control valve. An interesting exhibit will be a Mason Neilan 14-in. double-seat V-port diaphragm-operated control valve which stands some 7-ft. high and weighs over 1-ton. In addition to the working exhibits there will be representative examples of the complete range of Crosby and Mason Neilson valves, etc.

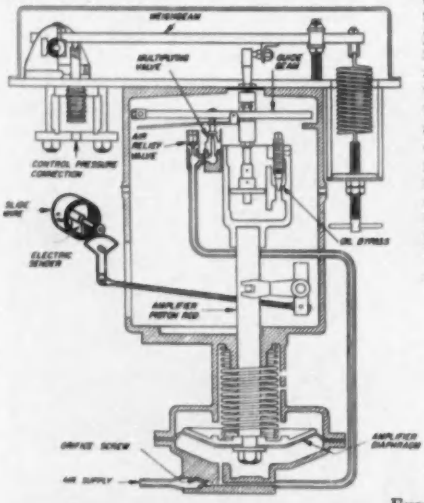
Dawe Instruments Ltd., *99, Uxbridge Road, Ealing, London, W.5*

The exhibits on this stand will include the company's type-412B pulse generator ; various types of oscillators ; valve voltmeters ; the type-1108 visigauge ; ultrasonic cleaning equipment for assemblies difficult or impossible to treat by other methods ; the "Soniclean" ultrasonic generator ; a high-frequency stroboscope ; various instruments for the measurement of sound ; and a vibration indicator. Also on show will be a heavy-duty console dynamic balancing machine, and the company's type-1254 portable balancing equipment. This latter equipment has been designed for balancing rotating parts *in situ* under normal running conditions, and is intended for use where the dismantling of a machine for this purpose would be a costly and lengthy procedure. Balancing can be carried out at speeds ranging from 1,000 to 15,000 r.p.m. The

instrument is suitable for measuring vibration amplitude and velocity over a wide range.

Electroflo Meters Co. Ltd., *Abbey Road, Park Royal, London, N.W.10*

Electroflo Meters Co. Ltd. (members of the Elliott-Automation Group) have for the past 20 years operated the largest



(Left). Diagrammatic arrangement of the Electroflo-Smoot automatic boiler control system

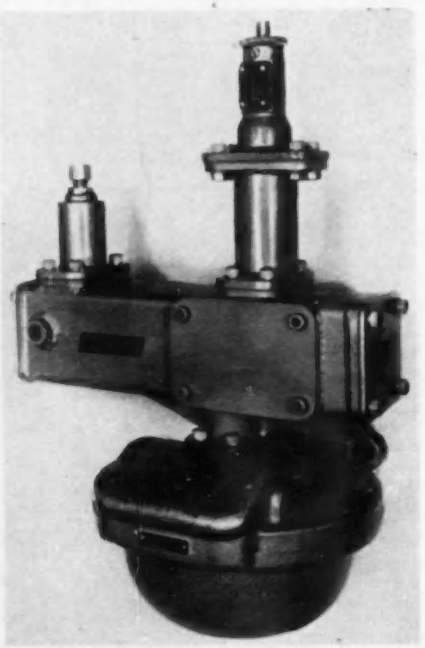
privately-owned hydraulics laboratory in Europe, and this exhibit will emphasise the result of the company's work in fluid dynamics. The recently-introduced Electroflo-Smoot electronic boiler control system will be featured, and display panels on the stand will illustrate open-hearth furnace control in the steel industry, and the application of a complete range of pneumatic automatic process control equipment for the oil and chemical industries. Electroflo remote supervisory control in the form of telemetering will be represented by an application to the gas industry. New additions to the company's range of equipment on show will include the model-197/7 electronic potentiometer of the high-speed indicating-type with push-button selection of up to 24-points. Other versions of the series-197 range of potentiometers offer a completely unobscured chart so that the set point is easily adjusted and is clearly visible from a distance. The construction is simplified by using only one rotating shaft and the potentiometers have a mechanism for continuous standardisation from a controlled voltage unit. The new series-198 range of potentiometers will also be exhibited. These are miniature instruments, being ideal for graphic or mimic control panels, and are available in various forms with numerous applications in process control systems. The new series-361 air-operated recording control station will be exhibited as a working model, and the application of the complete range of Electroflo miniature pneumatic instruments (indicators, recorders, and control stations) will be shown in graphic panels. There will also be a new printing flow-summator, working in conjunction with the standard Electroflo electrically-operated (integrating) flow meters.

Evershed & Vignoles Limited, *Acton Lane Works, Chiswick, London, W.4*

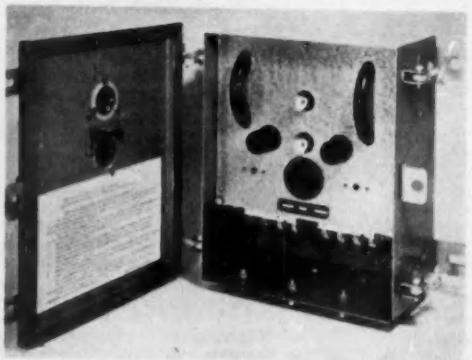
In the instrument section on the Evershed stand will be a complete range of "Megger" insulation and continuity testers; earth testers; and bridge testers; "Dionic" steam and water purity testing equipment; and a range of polarographs for chemical analysis. Ink-pen and tapping-type recording instruments include the Evershed miniature recorder, and the new quick-response recorder, while also displayed are F.H.P. motors; pencil thickness gauges for measuring the thickness of non-magnetic cratings on ferrous bases; and a range of switchboard and portable instruments. Included in the instrumentation and control section of the stand will be process control equipment based on the Evershed electronic repeater system of measurement and control. This equipment will comprise transducers for the indication and measurement of practically all physical variables; simple analogue computers requiring no programming, yet capable of performing such operations as addition, subtraction, multiplication, division, squaring and square root extraction; the new Evershed Mk. IV all-electronic process controller; and a range of electro-hydraulic and electro-pneumatic valve and damper positioners. In support of these individual items of control equipment, central displays will emphasise special Evershed systems applied to the chemical, refinery, nuclear energy and boiler control fields. A demonstration of flow control will show the Mark IV process controller operating from a magnetic flow meter and positioning a valve in a closed-flow circuit, while the application of Evershed control instruments to nuclear energy will be represented by an illustrated schematic diagram showing a number of simple analogue computors correcting flow for temperature and pressure, and finally correcting for calorific value.

Fielden Electronics Limited, *Wythenshawe, Manchester*

Fielden Electronics Limited will be exhibiting two new industrial level controllers, the Tektors Major and Minor, which operate on the well-established and patented capacity method. These instruments incorporate printed circuits for reliability and have a control knob on the front of the chassis which enables the set-point to be easily adjusted on site. Other features include triggered positive relay action, quick release chassis, sensitivity with stability, rugged



(Above). The Evershed & Vignoles Ltd. Master steam-pressure transmitter.



(Left). View showing the interior of the new Fielden Electronics Ltd. Tektor Major industrial level controller.

terminal blocks and industrial weather-proof cases. Greatly extended cable lengths are available which is an advantage in that the electronic unit may now be installed some distance away from the probe. Displayed with these instruments will be a selection from the company's range of electrodes. The following level measurement and control instruments will also be exhibited :— the Tektor JF3 flame-proof level-controller ; the Aquatrol conductive liquid-level controller ; the Telstor LF3 continuous level indicator ; and the Tektor TMI mobile level controller. A demonstration of accurate temperature control will incorporate the Fielden precision temperature controller and the electronic resistance thermometer recorder.

Foster Instrument Co. Ltd., *Letchworth, Herts*

The Foster Instrument Co Ltd. will be showing their complete range of temperature measuring and controlling instruments and equipment which includes their latest indicating and recording controllers of the electronic potentiometric self-balancing pattern. Two new standard instruments now included in this range are the transmitting version and the digitising version. Another new addition to the automatic control range is the model-3510 resistance thermometer controller, a small cased instrument with a scale length of 15-in., and with a minimum operating differential of 0.1 deg. C. Also to be shown are failure and safety alarm units for self-balancing potentiometric temperature controllers, smoke density detecting equipment, and a selection from the Foster range of internal inspection instruments. New equipment for boiler furnace observation will include a small portable water-cooled outfit and an automatically-operated periscope with viewing by closed circuit television.

Foxboro-Yoxall Limited, *Redhill, Surrey*

The Foxboro-Yoxall exhibit will cover the company's full range of instruments for measurement and control in the process industries. The actual equipment will include various indicators, recorders, controllers and transmitters, and the appropriate sensing elements for all the principal variables ; a graphic panel incorporating the compact Consotrol range, including the integrally-mounted recorder controller (M/54/58), the new computing relays (M/56), and the 14A integrator ; the new mercury-less bellows-type diaphragm flow-meter which measures a range of differential pressures from 20-200-in. of water at static pressures up to 2,000 lb./sq. in. ; and the Foxboro M/40-series of rectangular-cased recorder controllers with the newly designed pneumatic indicating controller, the M/41A. Also exhibited will be the range of Foxboro pneumatic transmitters including, a new direct-mounted liquid-level transmitter (the 13FA), and the magnetic flow-meter which measures the volume rate of all fluids with an electrical conductivity.

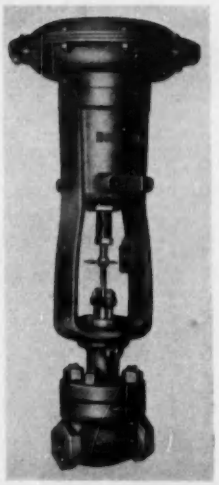
James Gordon & Co. Ltd., *Dalston Gardens, Stanmore, Middx*

James Gordon & Co. Ltd. (members of the Elliott-Automation Group) will have exhibits on two of the Group's stands. These will include automatic control equipment for all types and sizes of boilers, industrial furnaces, etc., with one particular exhibit comprising a control desk of the type associated with large pulverised-coal-fired boilers, on which will be mounted relays, auto-manual stations and instruments. Other equipment will be a control desk typical of the type used for the average stoker-fired industrial boiler ; a selection of

Gordon controllers for pressure, temperature, flow, etc., as used for process control, combustion control, etc. ; Gordon sequential control for soot-blowers and industrial processes ; power operators for valves, dampers, gates, etc. ; Mono gas analysis recorders including the Mono oxygen recorder, and recorders for CO_2, CO, H_2, etc. ; and Igema remote water-level indicators with new developments in telemetering and alarm equipment. Finally, there will be a selection of Gordon control valves, including butterfly and needle-type valves for pressure reduction, combined de-superheating and pressure reduction, overflow valves, etc. The company have for many years specialised in the design of special control gear and control valves to suit clients' requirements and have recently developed a new design of butterfly valve suitable for all sizes above 6-in. (patents applied for), which is claimed to be absolutely tight shutting.

Honeywell-Brown Ltd., 1, *Wadsworth Road, Perivale, Greenford, Middlesex*

Furnace temperature control equipment exhibited by Honeywell-Brown Ltd. will feature ElectroniK Electr-O-Line and programme controllers operating in tandem with indicating millivoltmeter controllers providing high-limit protection. A system of pneumatic instruments will show how flow, liquid-level and pressure are controlled in a fractionating column, and will include Tel-O-Set miniature instruments (incorporating for the first time two-pen recorders). Ratio flow control will be demonstrated by a cascade control system which can be utilised for the integrated control of oil, gas, steam and combustion-air flows. The well-known range of ElectroniK instruments exhibited will include two special models :—a high-speed recorder, and a Duplex recorder, which plots the values of two independent variables on the same chart. Direct-acting pressure controllers, represented by "Pressuretrols" and "Vaporstats,"



(Above). A typical example of a James Gordon control panel as installed in a recently commissioned power station of the C.E.G.B.

(Right). An example from the range of Honeywell-Brown diaphragm control valves.

will be a new feature of the display, and temperature equipment for industrial processes will comprise "Radiamatic" radiation pyrometers and a wide range of thermocouples and extension leadwires. Diaphragm control valves and final control motors complete the exhibit.

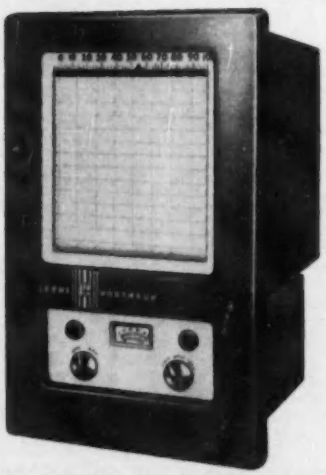
Hunt & Mitton Ltd., *Oozells Street North, Birmingham, 1*

Hunt & Mitton Ltd. will be showing a full range of process control valves up to 14-in. bore, of various types and manufactured in a variety of materials. Standard valve trim is of the well-known

"Nickloy" copper-nickel alloy, but other trim materials, such as stainless steel, are readily available. For suitable low-pressure services valves can, of course, be supplied with bronze or composition-disc trim. For the control of presses and other hydraulic machinery, in conjunction with time cycle controllers, the well-known "Sicol" pattern valves, made under licence from the Sinclair-Collins Valve Company of Akron, Ohio, U.S.A., are suitable for hydraulic working with pressures up to 6,000 lb./sq. in. The piloting of the hydraulic valves, or the entire control of compressed-air machinery, is catered for by the "Valv-air" range of pneumatic valves. There are also types made with air diaphragm motors working on 35 lb./sq. in. air supply, or 15 lb./sq. in. instrument air service. Solenoid-operated pilot valves are also made for use in conjunction with instruments having an electrical output signal. Where necessary Hunt & Mitton Ltd. have produced non-standard valves to meet individual requirements. One example to be shown is a very small (¼-in. bore) cylinder-operated shut-off valve designed for alternate pressure and vacuum service.

Integra, Leeds & Northrup Ltd., *183, Broad Street, Birmingham, 15*

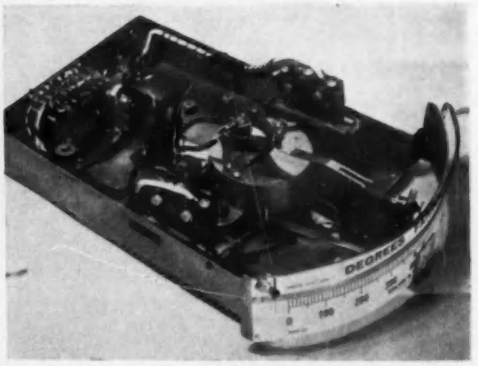
The Leeds Northrup exhibit will comprise a wide range of Speedomax and Micromax instruments for conductivity, load, voltage, force, humidity, pH, moisture, position, redox-potential, resistance, speed, weight, etc. These include the Speedomax G models which record X vs. Time, a measured variable being plotted against Time; another model recording up to 160 functions vs. Time, in which up to 160 points are scanned and recorded on one chart in less than 11 minutes; a model recording X vs. Y with two separate balancing systems to graph the relationship between any two variables which can be converted



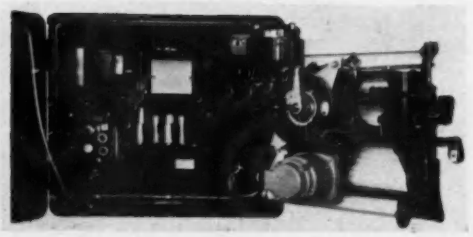
to appropriate electrical signals; and multi-point curve printing models in which, in place of a pen, a printing wheel prints a numbered dot for each of its primary elements up to 24. Exhibited for the first time is the new Long Door model of the recently introduced Speedomax H, in which the control unit, instead of being separately mounted on the panel, is now an integral part of the measuring instrument, the control unit pulling out like a drawer.

Kelvin & Hughes (Industrial) Ltd., *Livingstone College, Knotts Green, Leyton, London, E.10*

The Kelvin & Hughes (Industrial) Ltd. exhibit will include a number of instruments being shown for the first time. The multi-channel dynamic strain recording equipment facilitates the simultaneous recording of up to eight variables. Deflections of up to ± 2 cm. are obtainable with a 5-channel unit, and up to ± 1.2 cm. with an 8-channel unit. A 3-position indicating-temperature-controller of the photo-transistor type is of special interest where there are applications requiring the maintaining of controlled conditions within very close limits. Also exhibited are controllers with proportional as well as 2-position action. A new pressure controller for oil-fired boilers incorporates a photo-transistor circuit which has been especially developed for the automatic regulation of oil burners on shell-type boilers. The controller is of the proportional-action type and, through an electric positioning motor, regulates both the oil and air supplies, so maintaining constant stream pressure and optimum fuel/air ratios under varying load conditions. A new ultrasonic flaw detector—the Mark 6—offers greater versatility and higher standards of performance than have previously been achieved. There will also be a demonstration of the Kelvin Hughes ultrasonic flaw detector Mark 5, in an application of quality control in meehanite castings. In addition to manual techniques there will be a display of Autosonics, the Kelvin Hughes system of automatic non-destructive testing—showing an example of inspection for laminations in high-grade steel plates. Apart from the new items there will be examples of comprehensive instrumentation for small and medium sized boiler plants. Gas analysis, smoke detection, and the measurement of temperature, flow and draught will also be demonstrated.



The Kelvin Hughes 3-position indicating controller incorporating two separate control actions.



The new Long Door model of the recently introduced Leeds Northrup Speedomax H, in which the control unit is an integral part of the measuring instrument.

The Kent Mark 2A Multelec recorder, showing the instrument with the door and main frame in the open position.

George Kent Ltd., *Luton, Beds*

The main feature of the Kent stand is the Commander range of instrumentation including the recently introduced Commander KE high-speed self-balancing electronic recorders. Three units from the KE range will be shown, the first working as a temperature recorder-controller with a radiation pyrometer and a Mark 30 pneumatic-controlling unit, the second as an oxygen controller, and the third as a straight temperature recorder. An interesting application of the comprehensive Commander range to be exhibited is an assembly of instruments, all standard, which comprise a mass-flow computing installation. Flow-ratio control will also be demonstrated, using water-flow lines, by means of two more models in the Commander range, namely a flow recorder-transmitter (pneumatic) and a flow recorder-controller, the desired-value setting of the controlling instrument being adjusted by the pneumatic signal from the transmitter through a Remoset device in the controller—the controller's output then actuating a diaphragm control valve in the second flow line. A wide selection of other Commander instruments will also be exhibited, and other products in the electronic field on view will include the Mark 2A Multelec strip chart recorder, and the new Kent synchronous converter, working with an oscilloscope. The Kent servo-motor is also displayed. On another section of the stand a Multelec instrument is to be demonstrated as a flow-receiver in an electrically operated telemetering circuit, indicating, integrating and recording values of flow from two Commander flow-transmitting instruments. Further Kent products will include an RTE ring-balance instrument fitted with a Mark 20 pneumatic-controlling unit, together with diaphragm valves, and an RTE with a Mark 24 transmitting unit to illustrate

fuel/air ratio control. A single-point Universal pH recorder using the new Kent miniature primary elements will be demonstrated, and a three-point Universal pH recorder will be exhibited.

Negretti & Zambra Ltd., *122, Regent Street, London, W.1*

The Negretti & Zambra exhibit will comprise a selection of automatic controllers, measuring instruments and auxiliary equipment. Among the actual items will be controllers of the non-indicating, indicating and recording types ; air-operated programme controllers ; and electrical controllers. In addition to a number of indicating, and recording thermometers, the display will include pressure, draught and vacuum gauges, the new range of " Ivix " quality gauges ; and humidity indicators and recorders. Finally, there will be shown thermocouple and resistance element type electrical thermometers ; temperature transmitters (air and electrically-operated) ; fuel-flow meters ; boost gauges ; diaphragms ; capsules ; stacks ; and test barometers.

Payne & Griffiths Ltd., *Tudor Works, Windmill Lane, Smethwick, Birmingham*

Payne & Griffiths Ltd. will be exhibiting pressure gauges of all types suitable for steam, oil, air, water, gases, together with a wide range of other pressure equipment for the chemical, oil and engineering industries, including vacuum, combined, altitude, hydraulic, differential and electric contact gauges. Also exhibited will be diaphragm, bellows, capsule, and shock-resisting gauges for special purposes with English, metric and American dial markings and threads. Special purposes instruments for use with pressure systems will be displayed, in addition to a range of valves, cocks, etc.

Philips Electrical Ltd., *Century House, Shaftesbury Avenue, London, W.C.2*

The emphasis of the Philips Electrical exhibit will be on actual demonstrations of instruments and equipment representative of the company's range, and will include a number of new items. Shown for the first time will be a new series of nuclear research equipments including pre-amplifier, linear amplifier, electronic timer, single channel analyser, HT power unit and 5 kV supply. Other new items are an X-Y recorder and a high-impedance milli-volt recorder. Demonstrations will also be given of the stroboscopic X-ray examination of assemblies subject to vibration and housed in opaque materials—a new application of X-rays in non-destructive testing. Exhibited for the first time in this country will be a reactor control panel of a type now in production for the Netherlands atomic authorities.

W. G. Pye & Co. Ltd., *Granta Works, Newmarket Road, Cambridge*

Among a variety of instrument equipment on this stand, an exhibit of particular interest will be a demonstration panel showing how pH, conductivity and density can be continuously indicated and recorded. The liquid density section demonstrates how it is possible to control and record the density of liquids in a plant, the instrument used being a development of a design by the I.C.I. Ltd. staff at Billingham. By means of a hydrometer float, an electric signal (which is proportional to the displacement) is detected by a pick-up head. The signal, when amplified gives up to 1-mA output and can drive recorders or controllers. This instrument has many applications in accurate remote indication and recording of any linear movement over a range of 5-cm. The pH section is similar in design to the Pye industrial amplifier and recorder, while the conductivity section is based on the company's " W " conductivity meter.

Radiovisor Parent Ltd., *Stanhope Works, High Path, London, S.W.19*

The latest version of the industrial smoke density indicator alarm type-RV2 and the less complicated smoke alarm unit type-SA56 will be exhibited on the Radiovisor stand as demonstration models, with their accompanying recorders and indicators. Other items from the company's comprehensive range of equipment will include level controls ; and the series of Radiovisor Flamestat flame-failure protection equipment for gas, oil or pulverised-fuel, for which an auxiliary automatic light-up sequence controller has been produced to provide for purge and ignition periods and recycling. To provide automatic control on hoppers, vibrators, conveyors and similar devices a range of special photo-electric cell projections have been developed, including flame-proof and intrinsically-safe units, and examples of these will be displayed. The Radioviser event recorder which has been applied to many on/off recording operations on conveyors, hoppers and automatic machines will also be exhibited. For dust and fume density measurement a special control unit is to be shown. This gives stability, and permits discrimination of concentrations of the order of 00.5 grains/cu. ft.

Rotameter Manufacturing Co. Ltd., *330, Purley Way, Croydon, Surrey*

In addition to the well-established Rotameter flowmeters, this company will be showing a new range of industrial glass tube flowmeters (type-907) with an improved gland arrangement. The ends of the metering tubes are ground to accommodate a more rigid gland packing, e.g. P.T.F.E., than is normally tolerable with glass tube instruments. Special frames of welded construction have been produced, and flame-proof illuminators are available. Other new equipment will include a transmitting density meter for clean liquids ; a new form of electrical transmitting Rotameter flowmeter ; a range of flow alarms ; and accessories for the Ekstrom level indicator.

Sangamo Weston Ltd., *St. George's Court, New Oxford Street, London W.C.1.*

Sangamo Weston Ltd. will be showing a range of Weston electrical measuring instruments including laboratory standards, portable, switch-board and panel instruments as well as Weston standard cells, photo-electric cells, millivolt amplifiers, instrument switches, moving coil relays, tachometers and thermometer bulbs. A representative selection from the range of Sangamo time switches will be shown, and will include 24-hour dial, solar dial and short interval switches as well as hour meters and change-over switches. Also included will be a range of Sangamo electricity meters and metering accessories including the latest developments in single-phase and poly-phase watthour meters.

Smiths Industrial Instrument Ltd., *Chronos Works, North Circular Road, London, N.W.2*

Smiths Industrial will be exhibiting recent developments of the calibrated relay. Typical applications for which the relay is suitable are engine starter and overspeed protection, over-speed warning controlled differential, machine tool overload protection, etc., in fact any application requiring precise operation at a pre-determined speed, voltage or current. The outstanding characteristics of the calibrated relay are the high accuracy of $\pm$ 1 per cent. under static conditions, and the very low power input which is approximately 30 milliwatts. Another recent innovation is an industrial coupling, which uses an entirely new principle incorporating a magnetic circuit and a specially developed magnetic power. Notable features of the coupling include its resilience of operation which is said to be comparable to that of the hydraulic coupling. In addition, the characteristics of the clutch in the fully energised condition, i.e. no slip, is predetermined. The coupling is a constant torque device and the torque being directly proportional to the exciting current is in no way dependent on speed. Consequently, the power being transmitted by the coupling is directly proportional to the speed. Also exhibited is a repeat reversing unit, which utilises two couplings and is capable of being subjected to reversals in the order of 6,000 per hour ; hand tachometers; magnetic and electric tachometers; service counters; " Petro-Flex " flexible tubing; and oil and fuel pressure gauges.

Ronald Trist & Co. Ltd., *Bath Road, Slough, Bucks*

A working model of the company's Electricon smoke alarm, type ASB, for small boiler plants will be exhibited on this stand, together with the more comprehensive Electricon smoke density indicator, type C.S.B. for larger installations. A range of Mobrey magnetic level switches, available for pressures up to 3,000 lb./sq. in. (hydraulic applications 900 lb./sq. in.) and temperatures up to 750 deg. F., will be shown. On view for the first time will be a demonstration model of the Mobrey modulating level controller for maintaining boiler water-level closely in relation to the evaporation rate, and the Mobrey dual control which will shortly be available for working pressures up to 250 lb./sq. in. The function of this latter unit is to combine in one machine the operation of both electrically-driven feed-pump control and low water cut-off with alarm for automatic firing apparatus. A section of the exhibit will feature the comprehensive range of Seatrist seals, etc.

PHOSPHATES
in boiler water treatment

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is thoroughly established as the most satisfactory method of preventing calcium and magnesium scale deposits in all types of boilers. Such deposits cannot form when a phosphate reserve and correct alkalinity conditions are continuously maintained in the boiler water.

Indispensable at high pressures, phosphate conditioning at low pressures leads to such improvements in results that it is generally preferred to other forms of treatment.

Ask your supplier of boiler conditioning chemicals how little you would have to pay to be sure your boiler is scale-free *all the time*.

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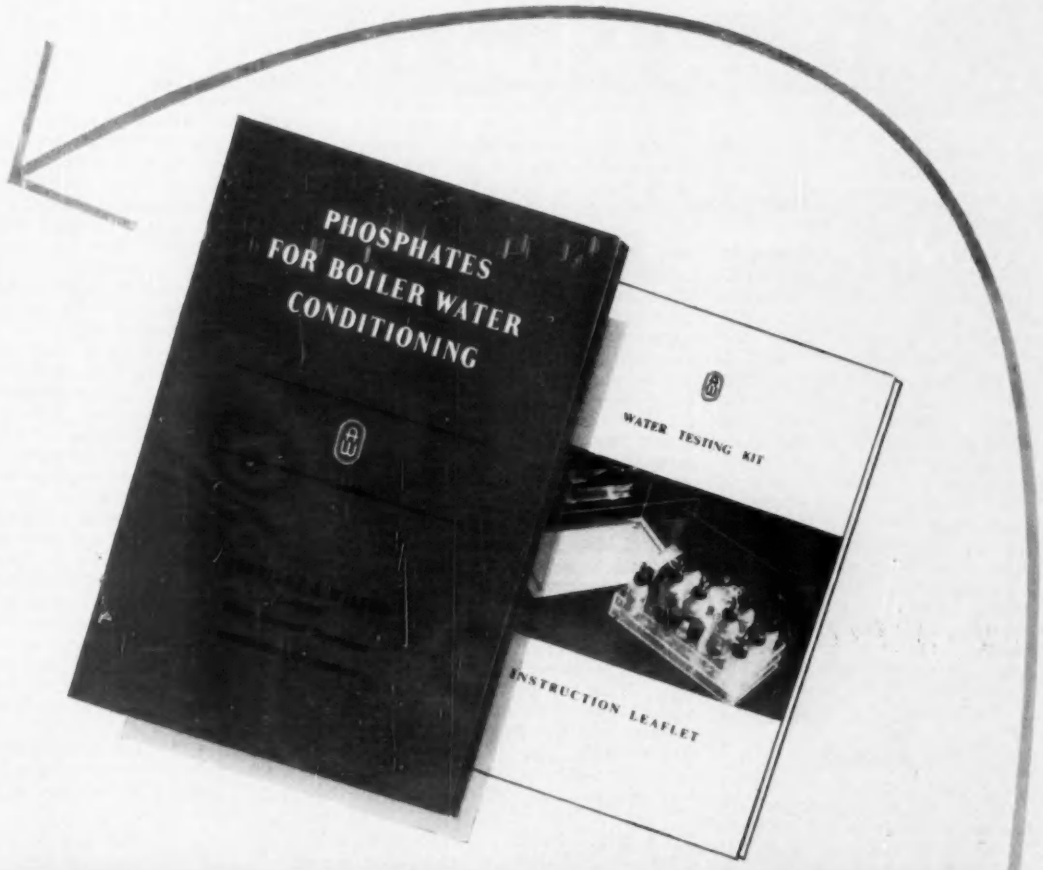

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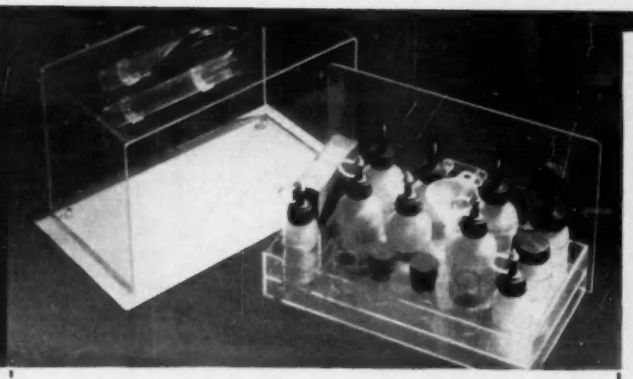

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Ask your supplier of boiler conditioning chemicals how little you would have to pay to be sure your boiler is scale-free *all the time.*

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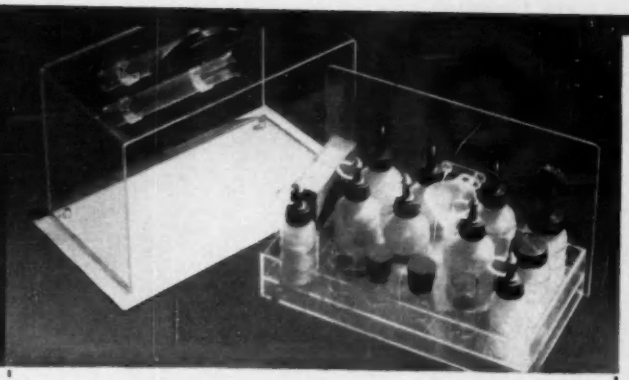

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Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

Steam generator

Although this invention is more of general utility, a boiler of the type described may be used as a steam generator in a coal-gasifier or a synthesis-gas reaction-unit in which the steam generator serves to cool the gases produced and generate steam for use in the synthesis-gas reaction, and/or for other uses. The invention includes a water-tube boiler having an upright cylindrical pressure-vessel enclosing a circular row of wall-tubes for conducting a fluid to be heated, and enclosing a space for the flow of a fluid heating medium under pressure. The tubes are suspended within the pressure-vessel and the pressure vessel is in turn suspended from a supporting framework, so that the tubes and the casing can expand downwardly and independently of each other. In Figs. 1 and 2, the synthesis-gas reaction unit incorporating a steam-generator is suspended from cross beams (11) of the structural

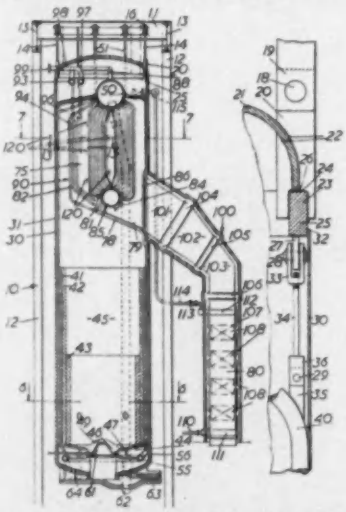


Fig. 1 (left). British Patent No. 789,587.

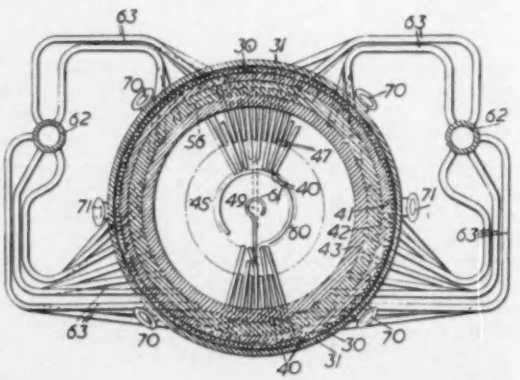


Fig. 2 (right). British Patent No. 789,587.

steel framework (10), including columns (12) and other beams (13) supporting the beams (11). The shell (30) encloses an upright circular row of steam generating tubes (40) and the casing comprising the shell (30), the head (21) and a lower head secured to the shell is covered with an outer layer of insulation (31). The inner surface of the shell (30) is in heat conductive contact with the tubes (40) so as to maintain the shell and tubes at substantially equal temperatures, and minimise differential expansion. The tubes (40) not only enclose the steam generating and superheating components laterally, but also help to form the lateral and bottom walls of a combustion chamber (45) which supplies the heating gases for the steam generator. In the case under discussion the heating gases comprise the hot products of a synthesis-gas reaction of constituents introduced into chamber (45). The lateral walls of the furnace or combustion chamber (45) are provided by refractory linings on the inner surface of tubes (40), supported from the furnace floor and extending over substantially half the height of the tube row. The lining is indicated as comprising three layers (41, 42 and 43). The layer (41) immediately against the studded tubes (40) extends substantially the full height of the furnace (45). The intermediate layer (42) may comprise 9-in. thick refractory shapes and extends the full height of furnace (45) and overlaps the upper end of layer (41). The innermost layer (43) may also comprise 9-in. thick refractory blocks and extends for substantially half the height of furnace (45). Water is supplied from a drum (50) to an annular header (55) by down-comer tubes (62), covered with insulation and connected at their upper ends to the outer ends of the drum (50). The lower ends of the down-comer tubes (62) are connected to the header (55) at uniformly spaced intervals by means of bent tubes (63). The tubes (63) may be suitably enclosed in an insulated ring casing section, and extend through thermal sleeves in the head (64). In addition to forming an outer wall, the tubes (40) also define a gas pass (75) containing the boiler tube banks and superheater of the steam generator. The tubes (40) may be 3½-in. o.d. tubes which are studded wherever they are in contact with a refractory lining, and they are substantially circumferentially contiguous to at least the upper end of the refractory lined furnace (45). The upper ends of the tubes (40) which continue to the top of the cylindrical tube bank are bent radially inwards, and at a slight upward angle, to connect into drum (50), and are covered with a layer of refractory material to form, together with the drum (50), the roof of the gas pass (75). Immediately above the tube sections (78), alternate tubes (40) in the cylindrical tube bank are bent inwards, as at (86), to provide a side outlet leading to an economiser (80). Saturated steam from the steam drum (50) is delivered from a saturated steam line (88) to an inlet header (93) of the superheater (90) which is of the pendent type comprising 2-in. o.d. tubes (94) connected into the header (93) and 1¼-in. o.d. tubes (96) connected into a superheater outlet header (97). The lower end of the superheater (90) extends to a point adjacent to the refractory wall (81), and this section of the

superheater comprises an elongated multiple sinuous loop. The tubes connected directly into outlet header (97) form a shorter loop adjacent the upper end of gas pass (75). A superheated steam line (98) delivers superheated steam from outlet header (97) to a flanged steam supply connection (99) outside the shell. *British Patent No. 789,587 issued to Babcock & Wilcox Ltd. Complete specification published January 22nd, 1958.*

Rotary regenerative heat exchanger

This invention relates to the mounting and supporting of the rotor of a rotary-regenerative heat-exchanger, and Figs. 3, 4 and 5 illustrate a preheater incorporating the invention. The apparatus comprises a stationary outer casing structure (10), a shell (12) and spaced end plates (14 and 16) between which the rotor is mounted. End plate (14) is provided with two sector-shaped openings or ports (18 and 20) located on opposite sides of a diametral plane through the heat-exchanger. These ports communicate respectively with ducts (22 and 24) for conducting one of the heat-exchange fluids to the rotor, and the other fluid away from the rotor. End plate (16) is likewise provided with sector-shaped ports (26 and 28), aligned respectively with ducts (30 and 32) for conducting the heat-exchange fluid from the rotor and the other fluid to the rotor. Countercurrent flow of the two fluids provides the most efficient heat transfer, and accordingly the plant illustrated is connected so that cold air to be heated is admitted through duct (30) and port (26) to the bottom of the rotor, and after being heated is discharged from it through port (18) and duct (22), as indicated by arrow (34), while hot gas to be cooled enters through duct (24) and port (20), flows downwards through the rotor and is discharged in the direction of arrow (36) through port (28) and duct (32). With such connections it will be evident that the upper end of the apparatus will be hotter than the lower end. The rotor encircling the hub portion (56) and indicated at (70) comprises an annulus having inner and outer shells (72 and 74), and radial partition walls (76) dividing the space between the shells into the sector-shaped compartments (78) which are provided at or near the bases with suitable supports, such as bars (80), for supporting heat-exchange plate elements (82). In accordance with a basic feature of the invention the rotor (70) is supported at its inner periphery by the bearings (60), rather than at or adjacent the centre or axis of rotation. The lower bearing member (84) comprises a rigid ring provided with a load carrying raceway (86) in the form of an annular recess which may be cut directly in the bearing member itself, and in the corners of which are circular lengths of wire (88) providing lower rails upon which a number of balls (90) may roll. *British Patent No. 789,945 issued to Svenska Rotor Maskiner A.B. Complete specification published January 29th, 1958.*

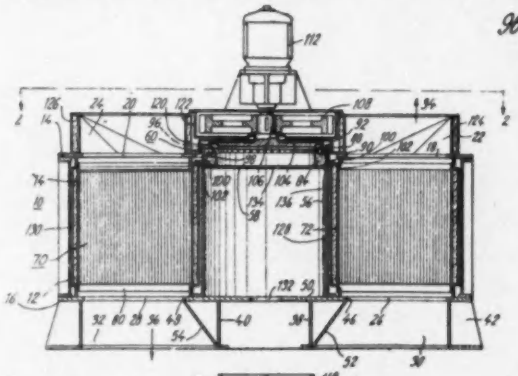


Fig. 3 (left).

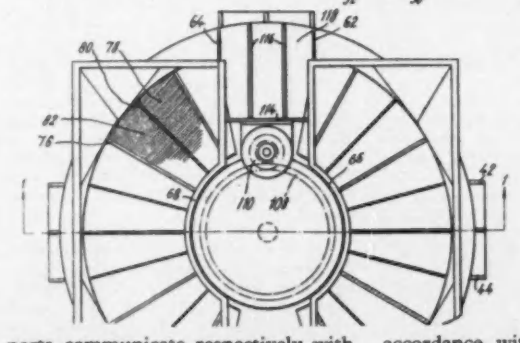


Fig. 4 (below, left).

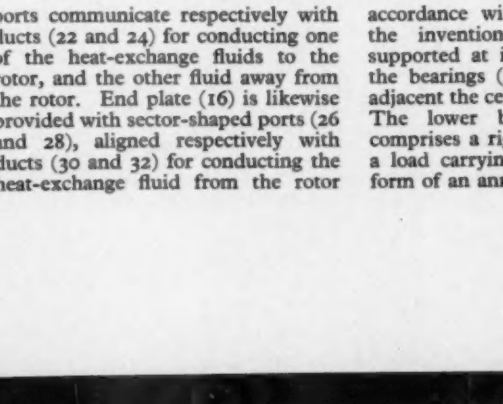


Fig. 5 (above). British Patent No. 789,945.

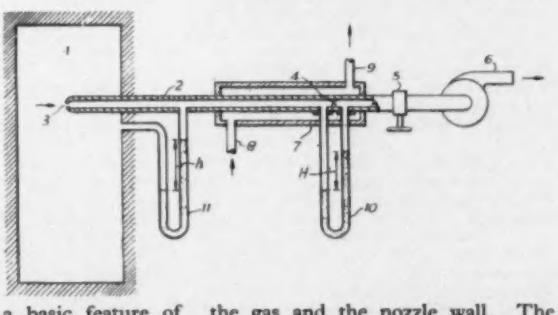


Fig. 6 (below). British Patent No. 790,393.

Gas temperature measurement

The gas temperature measuring device shown in Fig. 6 has a conduit (2) which is connected at one end to the suction side of a pump (6) and has at its other end an opening (3). A measuring pressure gauge (11) is connected across the nozzle-shaped opening (3) so as to measure the pressure drop across the nozzle. The conduit (2) is surrounded by a vessel jacket (7) which has an inlet (8) and an outlet (9). During operation a liquid having a constant temperature, e.g. boiling water, is caused to flow through the jacket (7). The size of the jacket (7) is such that it is capable of imparting to the gas flowing through the conduit a determined constant temperature at a point near the downstream end of the jacket. At this point an orifice (4) is located within the conduit (2) so that the gas is caused to flow through this orifice, and a second measuring pressure gauge is connected to the conduit (2) across the orifice (4). The conduit (2) is provided with a valve (5) between the jacket (7) and the pump (6) for adjusting the suction effect of the pump (6). The nozzle (3) is inserted into the chamber (1) in which the gas temperature is to be measured, for example, the combustion-chamber of a boiler. The nozzle (3) is provided with sharp edges so as to reduce to a minimum the difference of temperature between the gas and the nozzle wall. The valve (5) is so adjusted that the underpressure H_p at the gauge (10) in respect of the hot gas is the same as the underpressure H_v attained when ambient air was drawn through the apparatus for calibration purposes. Since the temperature of the gases at the orifice (4) remains unaltered, the

velocity of the gases through the orifice remains the same, as does the rate of flow of the gas. However, the temperature of the gases entering the aperture (3) will now be $T_{p3} > T_{v3}$ and therefore the velocity $W_{p3} > W_{v3}$, where W_{v3} is the velocity of air passing through the nozzle (3) during calibration. As the device is operating at a small underpressure, it is possible to use the equation :— $W_{p3}/W_{v3} = T_{p3}/T_{v3}$ and it can be shown that $T_{p3} = T_{v3} H_p/H_v$, where H_v is the underpressure in the pressure gauge (11) after introducing the pipe (2) into the space (1), T_{v3} being the absolute air-temperature outside the space (1). The scale of the apparatus is not influenced by an incidental alteration of the measuring nozzle (3) owing to corrosion or partial choking. In such a case the conduit (2) is withdrawn from the space (1), and while air is drawn through the apparatus, the drive of the suction device, or the valve (5), is so adjusted that an underpressure H_v appears at the pressure gauge (11) which corresponds to the temperature of the ambient air. After carrying out such zero correction, the scale will again indicate correctly the temperature of the gas which is to be measured. The radiation effect of the walls surrounding the space (1) does not influence the results of the temperature measurement, so that the actual temperature of the gas is indicated. *British Patent No. 790,393 issued to CKD-Dukla, Narodni Podnik. Complete specification published February 5th, 1958.*

The Institute of Fuel (Australian Membership) has elected **Mr. F. H. Roberts,** of Melbourne, as its chairman for 1958. Mr. Roberts is director and chief engineer of John Thompson (Aust.) Pty. Ltd., a member of the John Thompson Group, Wolverhampton. Mr. Roberts received his technical education at the Royal Melbourne Technical College and abroad, and joined the State Electricity Commission of Victoria in 1923. In his capacity of mechanical engineer, which post he occupied from 1948 to 1956, he was responsible for the design, technical construction, and the bringing into service of power stations, briquetting works, open-cut equipment, and general mechanical engineering plant. He has travelled abroad for the Commission on three occasions, the last visit being in 1951 to deal with design matters concerning brown-coal fired power stations, and to investigate developments in England, Germany and the U.S.A. Mr. Roberts is a member of the Institution of Engineers (Australia) and a Fellow of the Institute of Fuel.

* * *

Marconi Instruments Ltd., St. Albans, announce the formation of a new Engineering Group. The main duties of the group will be as follows :— general research investigations ; research in connection with nucleonics ; technical liaison with other research organisations ; and the applications of semi-conductors to the company's products. **Mr. G. M. Ettinger,** M.Sc., who previously held a senior post at the Whetstone Laboratories of The English Electric Co. Ltd., and has considerable experience in connection with transistors and magnetic amplifiers, has been appointed engineer-in-charge of the new group.

* * *

No less than 51 leading firms and associations will be represented at the first **Thermal Insulation Exhibition** at Earls Court, London, from April 14th-19th. The exhibition is being run in conjunction with the 6th **Factory Equipment Exhibition** which will be opened by the President of the Board of Trade, Sir David Eccles. Experts will be on hand to demonstrate diverse insulating material and methods including wood wool slabs, asbestos cement sandwich constructions, gypsum plasterboard, asbestos spray, insulating bricks, multiple glazing units, hollow glass blocks, precast floors, fibreboard, corkboard, expanded plastics, glass fibre, asbestos mattresses, and double glazed windows. During the exhibition, a one-day conference on the Thermal Insulation of Factory Buildings will be opened by Mr. Gerald Nabarro, M.P., on Thursday, April 17th. Mr. Nabarro was the originator of the Thermal Insulation (Industrial Buildings) Act, 1957, which provides that all industrial buildings erected after January 1st, 1959, shall be regulated against loss of heat to a standard prescribed in regulations laid down by the Minister of Power. The purpose of the conference is to explain to those concerned with planning industrial buildings what they are required to do, how much it will cost and what benefits will result.

* * *

Richardsons Westgarth (Hartlepool) Ltd. have received notification from the Central Electricity Generating Board that an order is to be placed with them for the construction, erection and commissioning of two 120-MW reheat steam turbo-alternator sets, the value of this order exceeding £1¼ million. The C.E.G.B. and their predecessors, the Central Electricity Authority, have for some considerable time been customers of Richardsons Westgarth, who have provided them with many large Richardsons Westgarth-Brown Boveri turbo-alternator sets for a number of power stations in the British Isles. An outstanding example is the Portobello (Edinburgh) station of the South of Scotland Electricity Board, which for many years has been the most efficient generating station in operation, and which is equipped with three 60-MW cross-compound sets constructed by Richardsons Westgarth.

* * *

"Rocksil" rigid pipe sections are announced by **The Cape Asbestos Company Limited** as the latest addition to this well-known range of rock wool insulation materials. Rocksil rigid pipe sections are, it is claimed, mechanically very strong, and are manufactured to an extreme degree of accuracy, ensuring uniformity of pipe diameters and wall thicknesses. Three feet in length, these pipe sections have a uniform density (10 lb. per cu. ft.) and superior finish. They are available in thicknesses ranging from ½ in. to 2 in. at ½ in. intervals, both canvas wrapped with and without bands and scrim cloth wrapped with and without bands. They are designed to provide inexpensive pipe line insulation for every type of domestic, industrial and marine requirement in the temperature ranges up to 600 deg. F.—hot water lines, steam lines and steam traced oil lines—and also frost protection of cold water piping.

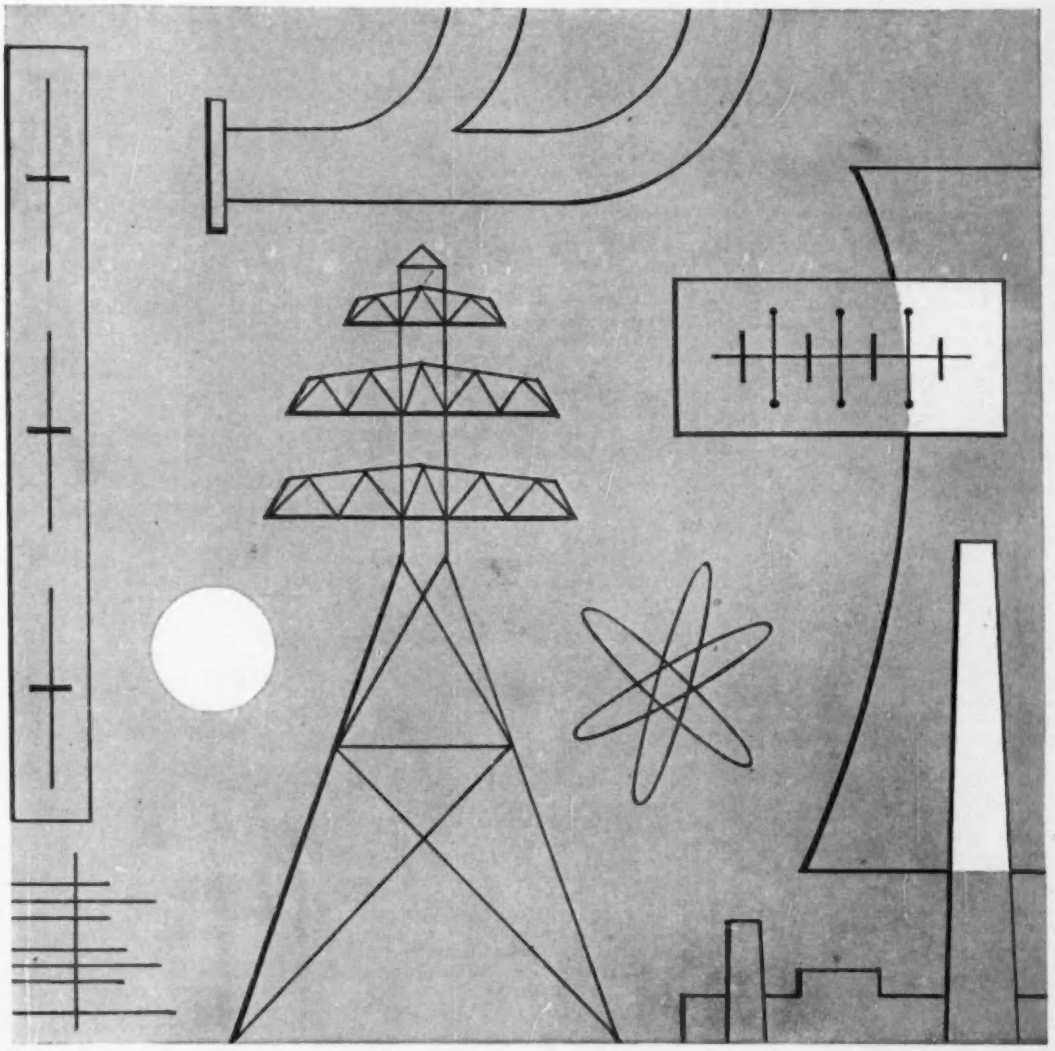
Metropolitan-Vickers Electrical Co. Ltd., has been awarded a contract valued at approximately £1½ million, covering the construction and equipping of the Gach Saran Power System for the Iranian Oil Exploration and Producing Company. The scheme will comprise a 12-MW power station, switchgear, transformers and transmission lines in the Gach Saran oilfield located some 2,500 ft. above sea-level in Southern Iran, whence oil will be piped to a new sea terminal at Kharg Island in the Persian Gulf. Sub-contractors for the associated civil engineering are Richard Costain Ltd., and for the transmission lines and cable work British Insulated Callender's Construction Co. Ltd. The consulting engineers are Messrs. Ewbank & Partners Ltd. The complete system is to be commissioned in May, 1960. Power generating plant will comprise three Metropolitan-Vickers L.51.C gas-turbine-generators nominally rated at 4,000-kW ; the maximum rating of each unit will be 5,500-kW. The L.51.C gas-turbine is one of the standardised range of Metropolitan-Vickers industrial units for operation on natural gas or oil fuels, and suitable for base load, peak load or stand-by duties. The Gach Saran machines will burn natural gas from the oilfield.

* * *

"Bestobell Globe Valves" is the title of the latest addition to a series of publications available from **Bell's Asbestos and Engineering Ltd.,** Bestobell Works, Slough, Bucks. This describes the company's standard range of globe valves which are supplied, manufactured from various body materials (bronze, cast or forged steel) and in various forms to cover working steam pressures from 180-600 lb./sq. in. and working temperatures from 380-850 deg. F.

* * *

The fourteenth issue of "**Electricity in Industry**"—technical review of the Lancashire Dynamo Group of Companies—has just been published. It contains four main articles. These are concerned with recent developments in the field of variable-speed drives, roller bearings for small motors, vehicle battery charging and transformer core steel. The latter article is one of a series which, in this issue, covers methods of use and processing of high grade transformer core steel. Copies of the publication are available from Lancashire Dynamo Group Publicity Services, St. Stephen's House, Victoria Embankment, S.W.1.



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NOTES Personal AND Industrial

We regret to record the death on March 16th of **Mr. C. K. Bird,** who until he relinquished the position for health reasons at the end of March, 1956, was manager of BTH turbine contracts department at Rugby. From that date he was consultant to the manager, turbine contracts. Mr. Bird, who was in his sixty-sixth year, was educated at Tettenhall College, Wolverhampton, and King's College, Cambridge. He joined BTH as a student apprentice in 1919, and was appointed assistant manager in 1919, became a member of the contracts department in 1922, and was appointed assistant manager of turbine contracts in 1943. He succeeded Mr. H. G. Rowe as manager in July, 1945.

* * *

Mr. Eric E. R. Fuchs, M.I.E.I., A.I.Loco.E., has now joined Ruston & Hornsby Ltd., Lincoln, as personal assistant to Mr. T. L. Kendall, sales director. Mr. Fuchs joined the English Electric Co. Ltd., at Rugby in 1938, and was engaged on diesel engine research and development. Later he became technical delegate in the Middle East for the entire English Electric Group, returning to the diesel engine division in 1952 as assistant to the general manager.

* * *

Mr. B. W. Dawkins has been elected chairman of Saxon Engineering Company Limited and Bennis Mechanizations Limited, both of Fenton, Stoke-on-Trent, and of subsidiary companies of Bennis Combustion Limited, Little Hulton, Walkden, Manchester. Mr. Dawkins is joint managing director of the parent company Bennis Combustion Limited.

* * *

We are informed that **Mr. R. A. S. Lomax,** A.M.I.Mech.E., has been appointed a director of Ashwell and Nesbit Ltd., Leicester.

* * *

Baldwin Instrument Co. Ltd., Dartford, announce the appointment of **Mr. John D. Thornley** as Northern England representative of the Fluid Power Division. Mr. Thornley will be operating from the following address :— Waterhey Cottage, Rivington, Nr. Bolton, Lancs. Telephone : HORwich 364.

* * *

The Steel Company of Wales Ltd. has announced the appointment of **Mr. M. C. Harrison** as manager of the new Bessemer steel plant, which is now under construction at Abbey Works. **Mr. P. Truscott** has been appointed assistant manager.

* * *

International Combustion Ltd. and **International Combustion (Products) Ltd.** have opened a new office at 22, St. Mary Street, Cardiff (telephone : Cardiff 26648). **Mr. R. W. Allison** has been placed in charge of this office.

Mr. A. V. Sowman, M.I.E.E., has been appointed managing director of Crompton Parkinson (Chelmsford) Ltd.

* * *

Mr. A. McLellan, C.A., deputy accountant of the North West, Merseyside and North Wales Division of the Central Electricity Generating Board, has been appointed divisional accountant in the North West, Merseyside and North Wales Region of the Board.

* * *

Zwicky Ltd., Slough, Bucks, inform us that **Mr. George C. Turvey,** B.Sc. (Econ.), has been appointed as sales director of the company.

* * *

Mr. F. H. Lawder, chief labour superintendent of the United Steel Companies Ltd., has been elected president of the Iron and Steel Trades Employers' Association in succession to **Mr. W. F. Gilbertson.**

* * *

Mr. L. F. Miller, deputy chief contracts officer of the Central Electricity Generating Board, has been appointed chief purchasing and contracts officer of the board. Mr. Miller joined the sales department of W. T. Henley's Telegraph Works Co. Ltd. in 1929, and two years later, the purchasing department (engineering division) of Edmundsons Electricity Corporation Ltd. After war service he was appointed secretary to several engineering committees of the British Standards Institution and on the reorganisation of the electricity supply industry he became senior assistant to the purchasing officer of the Eastern Electricity Board. In 1949, he joined the Authority's headquarters staff as analytical officer (generation construction branch), subsequently becoming principal assistant contracts officer and then, in 1957, deputy chief contracts officer.

* * *

After 39 years' service with the British Thomson-Houston Company, Rugby, **Mr. F. G. James,** B.Sc., A.M.I.E.E., has retired. He spent most of his career in the industrial engineering department but for the past two years has been personal assistant to **Mr. G. S. C. Lucas,** director and chief electrical engineer. Mr. James served his apprenticeship in 1912-14 with the British Westinghouse Electric and Manufacturing Co. Ltd., now Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, and in 1919 joined the BTH publications (now publicity) department. He was transferred in 1922 to the industrial engineering department, remaining there for 33 years, during which he became section leader of the paper, printing and textile section. In 1955, he was appointed personal assistant to Mr. G. S. C. Lucas, in which position he remained until his retirement.

* * *

The Plessey Co. Ltd., Ilford, announce that **Mr. W. Dalziel,** production manager of the Electronic and Equipment Group, and **Mr. H. Fox Wright,** contracts manager of the company, have been appointed executive directors.

* * *

The Minister of Power has re-appointed **Sir George Gater,** G.C.M.G., K.C.B., D.S.O., J.P., as a part-time member of the London Electricity Board.

* * *

We are informed that the address of **The Professional Engineers Appointments Bureau** is now 39, Victoria Street, S.W.1. The telephone number remains unchanged (ABBey 1737).

* * *

Dewrance & Co. Ltd., well known as manufacturers of valves, boiler mountings, etc., announce that their subsidiary company **Jones, Tate & Co. Ltd.,** Victory Works, Bradford, is now to operate as a division of the parent company, to be known as the Jones Tate Division. **Mr. C. E. Jones** has retired and **Mr. P. F. Gifford** has been appointed divisional manager. **Mr. A. C. Jones,** A.M.I.Mech.E., is appointed sales manager, and operates from the London office, 165, Great Dover Street, S.E.1 (tel. : HOP 3100). This division manufactures a wide range of powered, automatic and solenoid-operated valves. Correspondence other than that concerning sales will continue to be addressed to Victory Works, Bradford.

* * *

Metropolitan-Vickers Electrical Co. Ltd. announce that the address of the company's Sheffield district office is now :— 9, Market Place, Sheffield, 1. The telephone numbers, Sheffield 23114-7 and 27848, will remain unchanged.

* * *

It is announced that sums totalling £450 were awarded during 1957 from the Maudslay Scholarship fund. Three scholarships of £100 each were awarded, and there were three special prizes of £50 each. The **Maudslay Scholarship Foundation** provides the funds for the scholarships, and these are administered jointly by the Junior Institution of Engineers and the Maudslay Society. Awards are made annually for the purpose of assisting young engineers in their technical engineering and practical training. The rules for the 1958 award will shortly be announced.

* * *

Foxboro-Yoxall Ltd. inform us that they are now occupying their new offices at Redhill. Correspondence should be addressed :— Foxboro-Yoxall Ltd., Redhill, Surrey. The telephone number is Redhill 5000. The move to these new premises allows for the increased production now required, and also a reduction in delivery period. The company has taken the opportunity of expanding activities in every department, particularly technical sales and service facilities.

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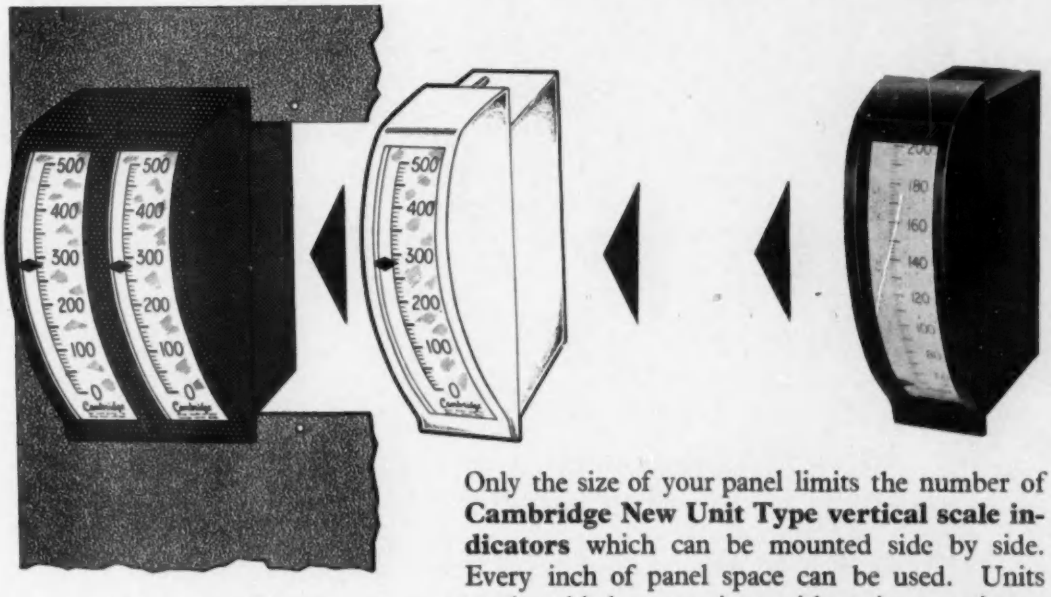

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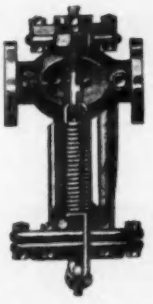

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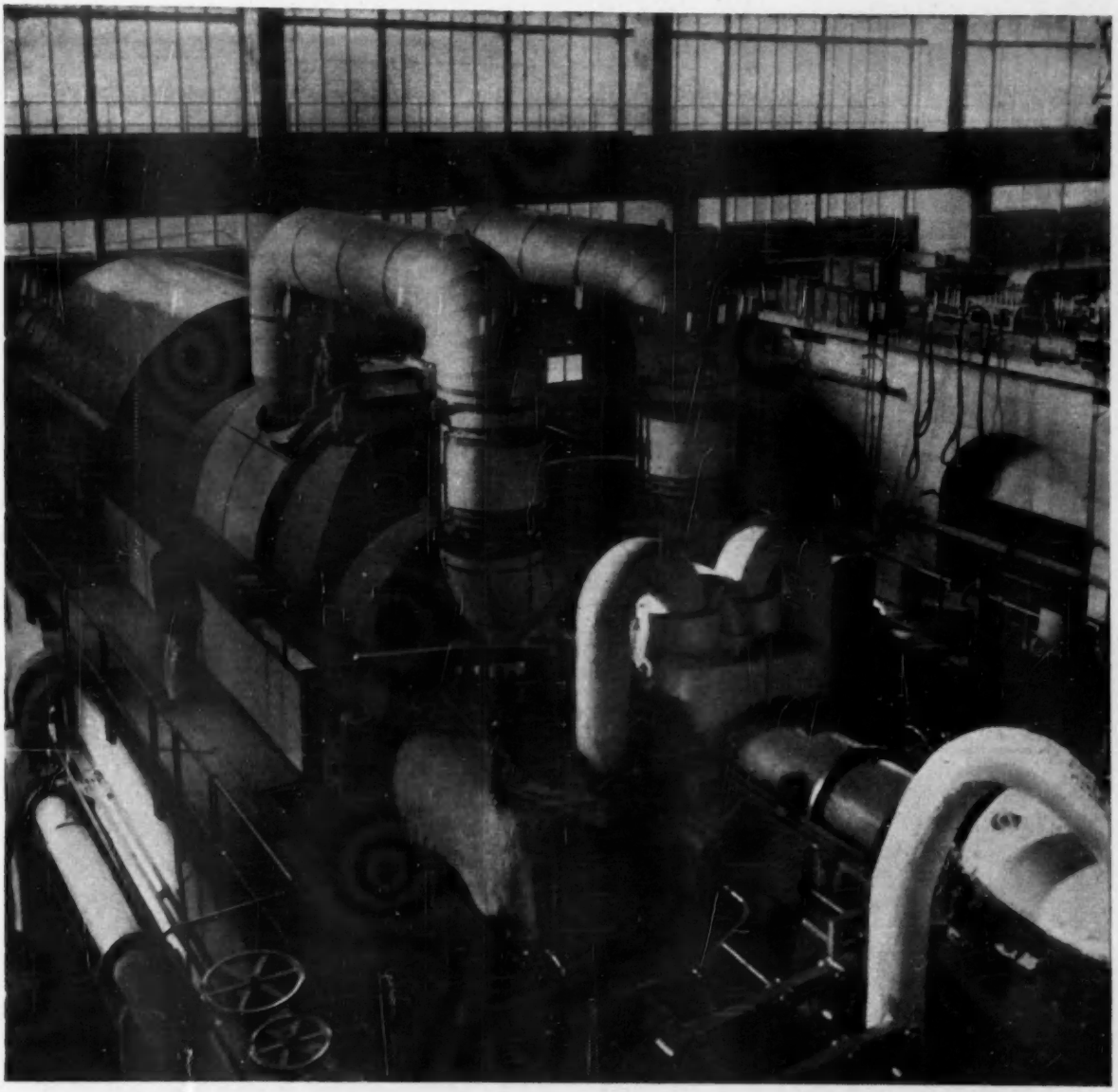

100 MW turbo-generators nearing completion

The installation of three PARSONS 100 MW turbo-generators is well under way at The Central Electricity Generating Board, Ferrybridge Power Station, Yorkshire. Here is the first machine nearing completion; it is now in operation. Steam conditions: 1500 lb/in² pressure, 975° F. temperature and reheat to 950° F.

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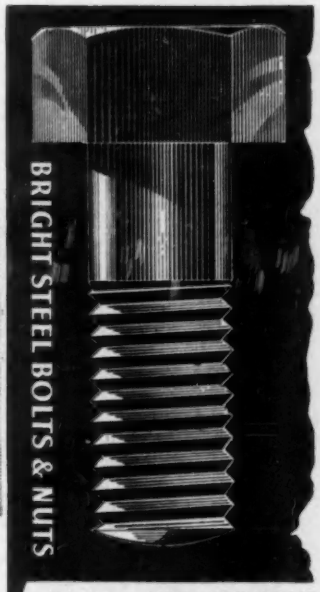

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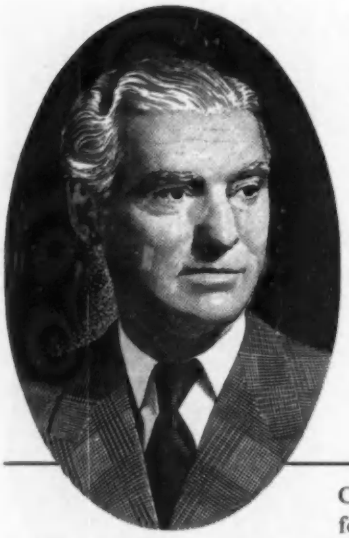

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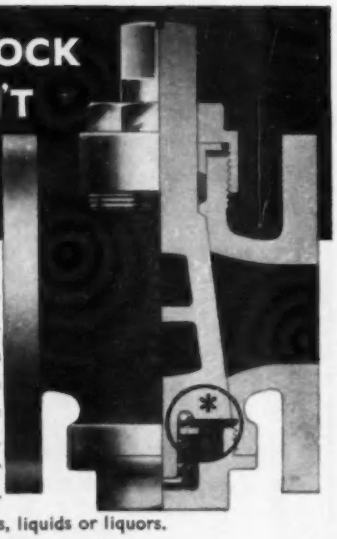

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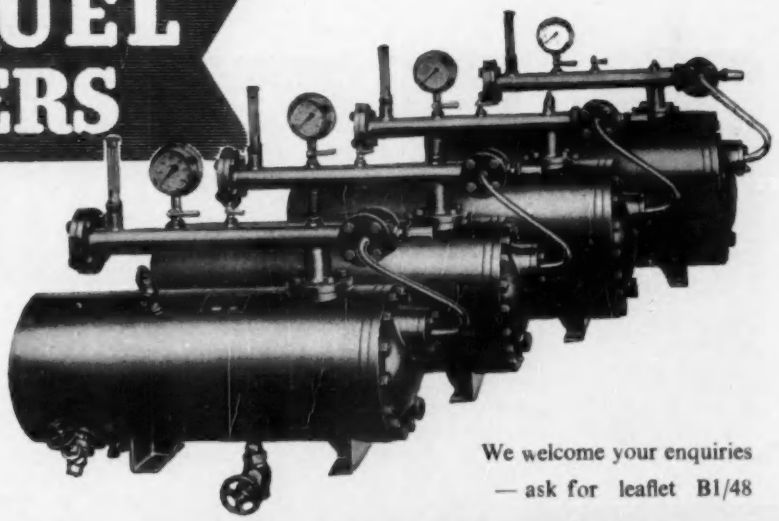

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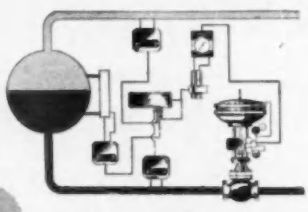
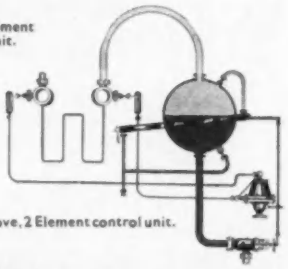


Left, 3 Element control unit.



Above, 2 Element control unit.

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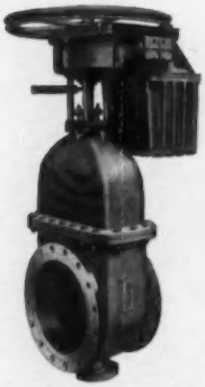

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Boiler-house Construction

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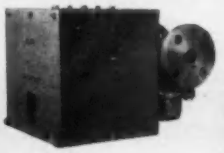

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DEFUR LTD. are specialists in CHEMICAL DESCALING of Boilers (all types) and ancillary Steam Plant, Process Plant, Water Mains, Gas & Marine Plant, etc.

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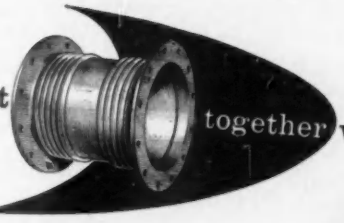
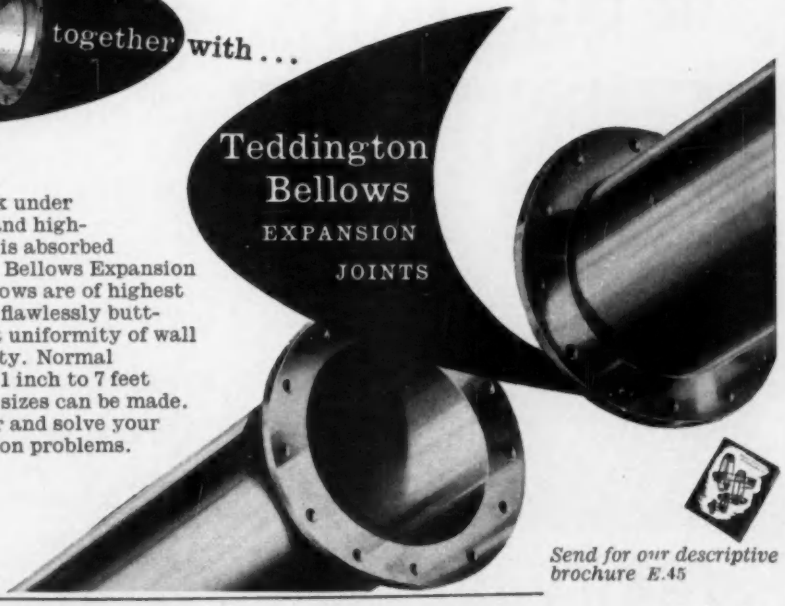
Let's get  together with . . .

Teddington Bellows EXPANSION JOINTS



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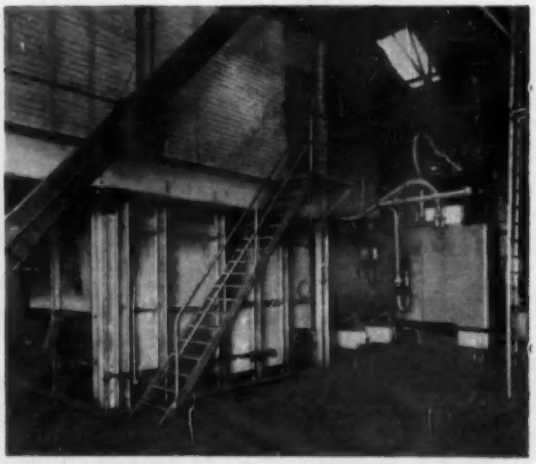

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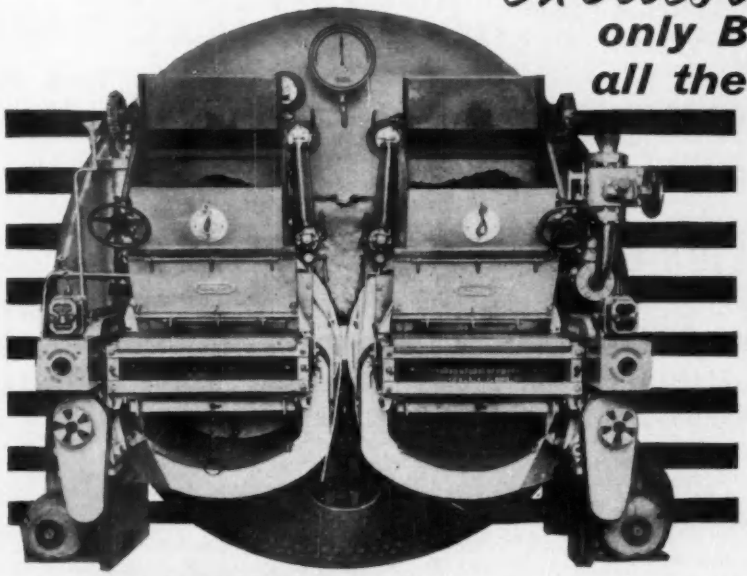

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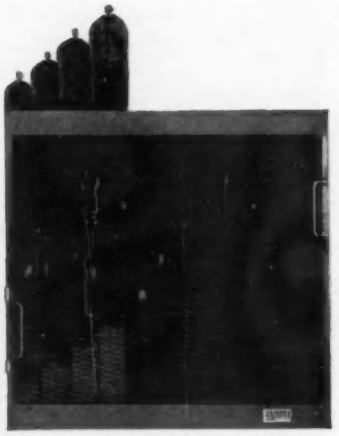

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For injection direct into the combustion zone of boilers and furnaces burning

RESIDUAL FUEL OILS, COAL and PULVERISED FUEL FOR REDUCTION OF SULPHUR CORROSION, FOULING and SLAGGING,

while maintaining maximum efficiency and availability

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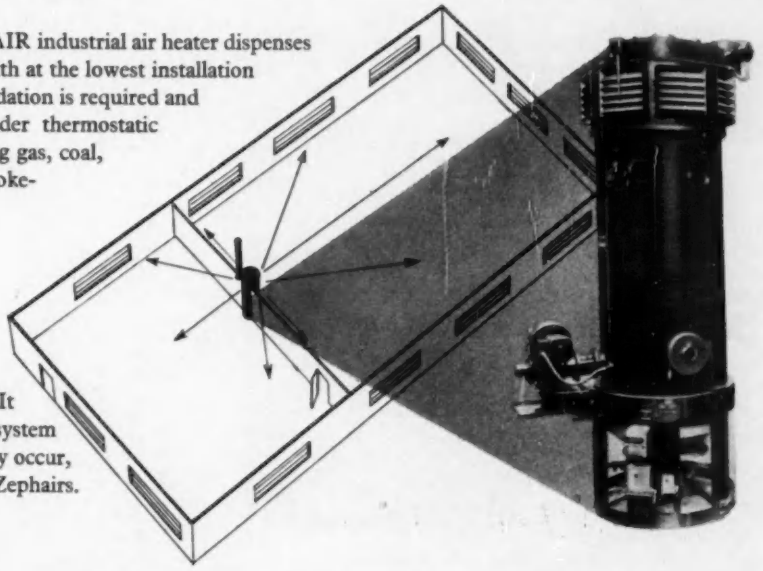

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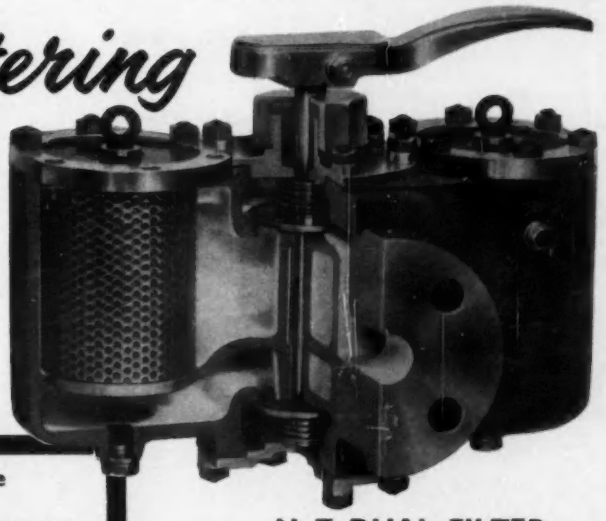

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"The Lancaster"

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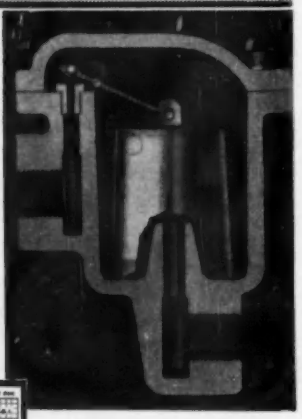

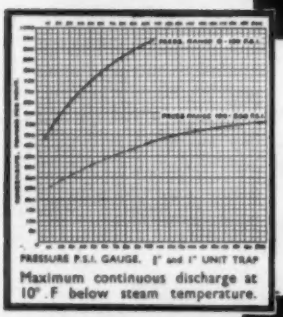

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PRESSURE RANGES 0-100 P.S.I. Sat.
and 100-200 P.S.I. Sat.
will lift 2 ft. for each 1-lb. of steam pressure in the trap.

MADE IN THREE SIZES:
½", ¾", and 1" B.S.P. or A.P.I.

Self supporting on the pipe-line.

Discharge capacity of ½" trap approx. half of above graph.

For further details ask for List No. 98

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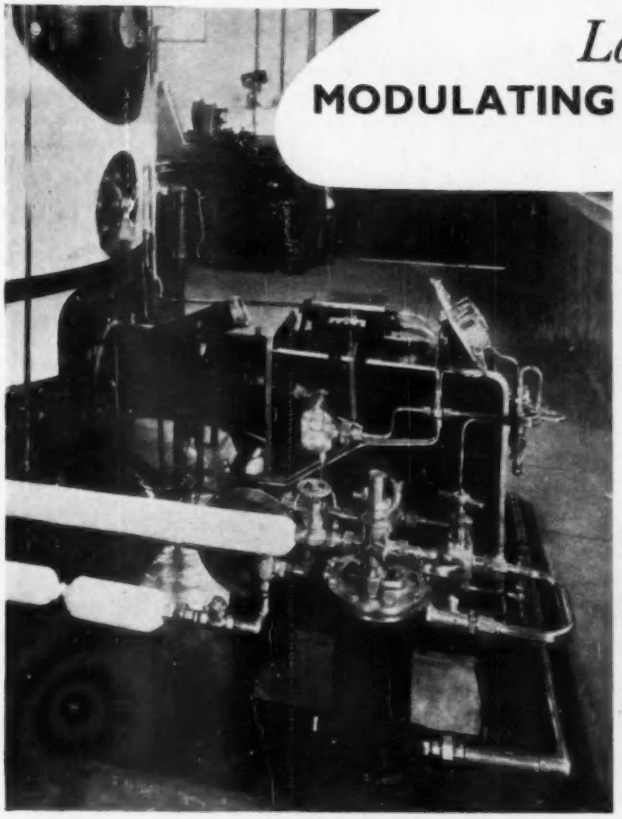

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for all grades of fuel oil up to 950 sec. Redwood No. 1 at 100° F. and for capacities up to 800 lb. of oil per hour.

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tube-cleaning equipment

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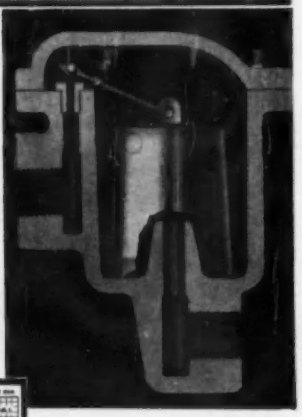
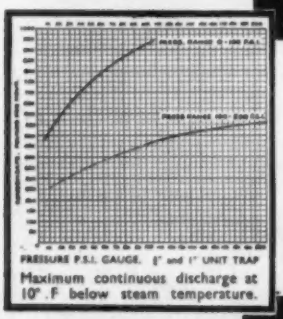
"The Lancaster"

UNIT STEAM TRAP





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Maximum continuous discharge at 10° F below steam temperature.

. . . A NEW TRAP BY AN OLD MAKER

it's small, it's efficient, it's low in price

it's NEW

Particularly suitable for use with Unit Heaters, Laundry Calenders, Tumblers, Presses, etc. Calorifiers, Heated Cavity Tables, Sterilisers and anywhere where unit trapping calls for a number of small inexpensive steam traps.

PRESSURE RANGES 0-100 P.S.I. Sat. and 100-200 P.S.I. Sat. will lift 2 ft. for each 1-lb. of steam pressure in the trap.

MADE IN THREE SIZES: ½", ¾", and 1" B.S.P. or A.P.I.

Self supporting on the pipe-line.

Discharge capacity of ½" trap approx. half of above graph.

For further details ask for List No. 98

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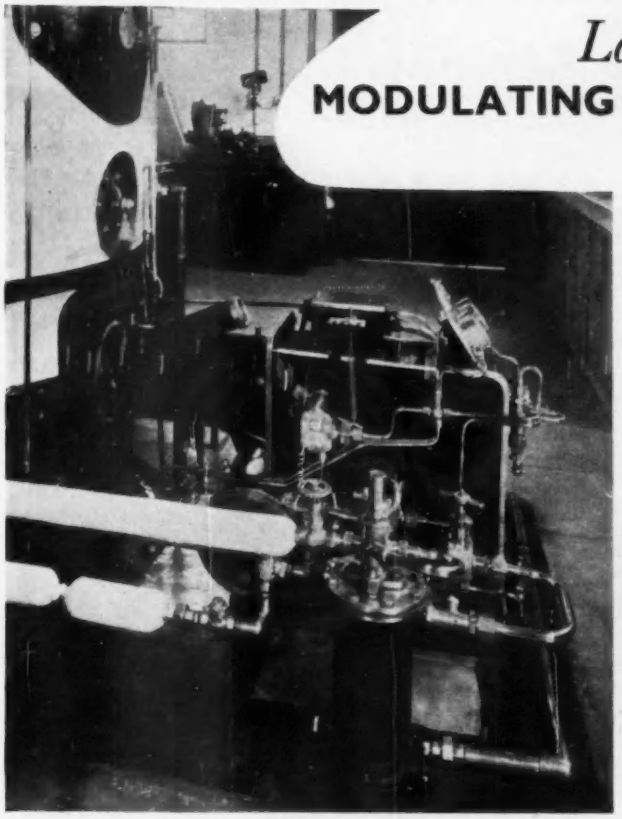

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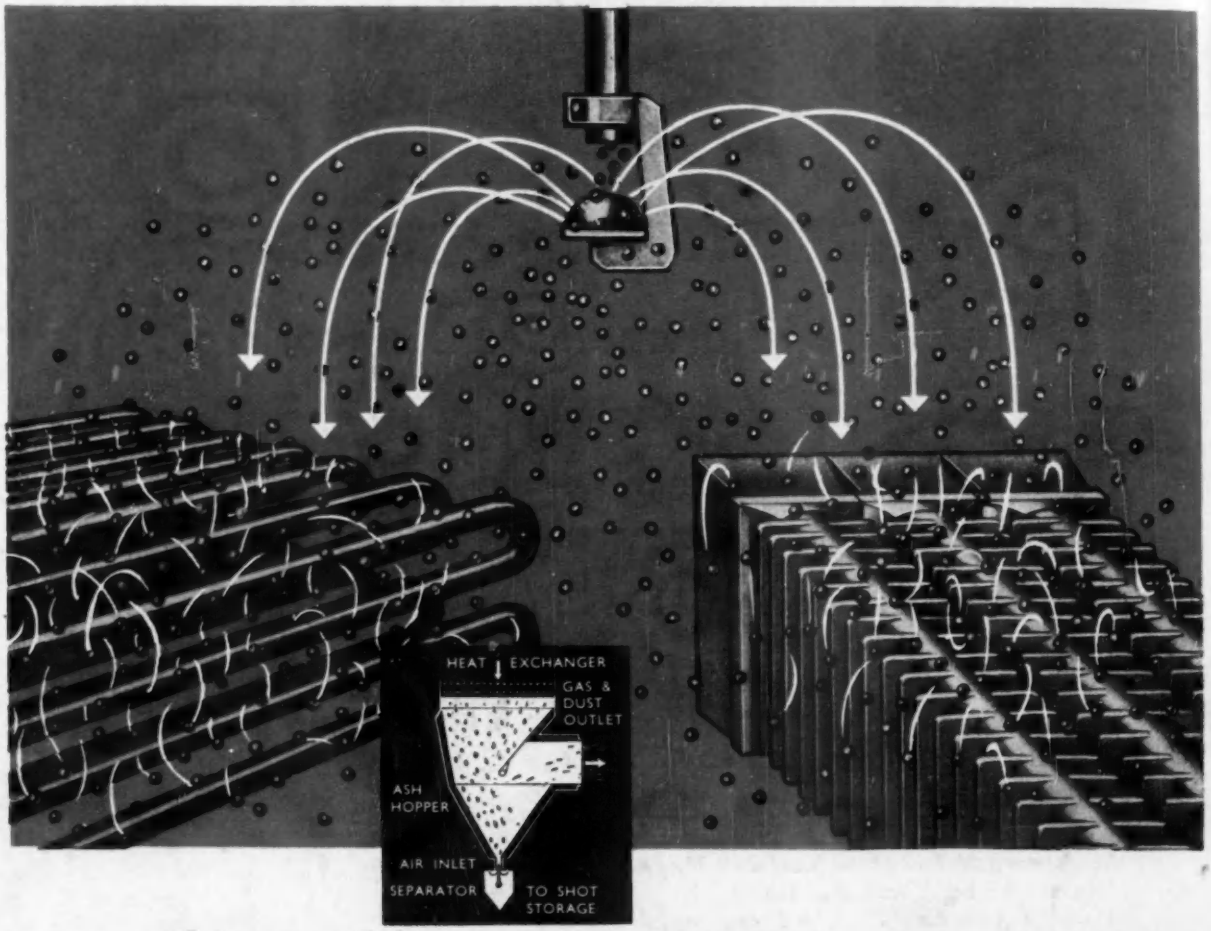

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